

RADIOLOGY

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RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

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Orthovoltage Rotation Therapy: Six Years Experience in a General Hospital¹

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and NORMAN TALAL, A.B.

SIX YEARS AGO, in order to utilize fully the physical characteristics of the conventional therapy equipment available in the clinic radiotherapy section of the Presbyterian Hospital (New York), a rotation therapy chair was designed and built. From the outset our attitude, as previously expressed (1), was that rotation therapy was an extension of multiple portal technic, complete rotation representing an infinite number of portals around the body of the patient. Complete rotation was not necessarily adhered to; rather, such technics as scanning and a combination of scan segments and fixed ports were utilized in an effort to obtain the optimum physical treatment plan for a particular clinical situation. At this point, stimulated by a desire to know what had been accomplished and in which instances we had actually utilized this technic, and by the installation of a supervoltage instrument (betatron) which provided an easy solution to many treatment problems, it was felt that a review of our material was in order.

The rotation instrument was located in one of the four radiotherapy sections of our center, so that the total case material available was relatively small. The cases, however, represent the total available patients with cancer in an 850-bed general

hospital including all major and minor services, except neurology and ophthalmology, and the clinic outpatient department. From April 1951 until Dec. 31, 1956, 1,165 patients with malignant disease were accepted for treatment. There were also 24 with pituitary adenomas. Of the total number 144 were selected for rotation therapy.

In order to demonstrate the utilization of the rotation equipment and to clarify the indication for such a treatment method, an analysis of each case with regard to such factors as site, extent of disease, and size of portal was undertaken. It was also felt that a study of the dose delivered, the responses during treatment, the occurrence of moist desquamation and unfavorable sequelae would be indicative of the clinical advantages or disadvantages of rotation therapy. An expansion of our experience in the treatment of these cases follows.

HEAD AND NECK

Other than a miscellaneous group, carcinomas of the head and neck represented the largest single group of patients referred; 205 lesions of this region were treated. Fifteen were selected for rotation. Since many head and neck lesions well qualify for rotation therapy in that

¹ From the Department of Radiology, College of Physicians and Surgeons, Columbia University, and the Radiological Service of the Presbyterian Hospital, New York, N. Y. Presented at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17-22, 1957.

they are of small diameter and relatively centrally located, an explanation for this small number is in order. Perhaps the most important reason for limiting the head and neck cases subjected to rotation is the suitability of these lesions for resident training. In recognition of the fact that all radiologists may not have rotation therapy available, the head and neck area was reserved in most instances for

gone a full course of radiation by fixed port technic. A recurrence five months later was retreated by rotation.

The average tumor dose which this group of patients received was 5,800 r in five and a half weeks. The average port size was 5.5 cm. wide \times 7 cm. in height. All of the patients save one tolerated treatment excellently. This particular patient, with an extensive tumor of the

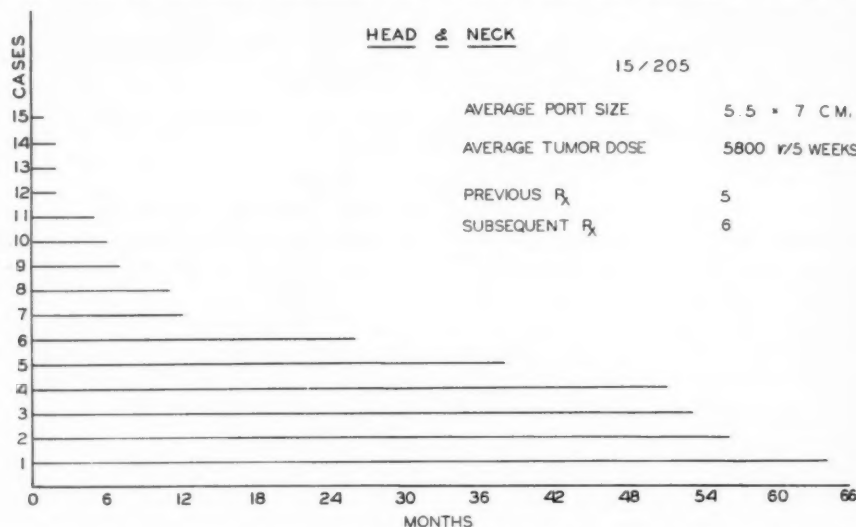


Fig. 1. Survival, in months, of 15 patients with tumors of the head and neck.

the application of the multiple port technic by means of beam direction with casts. The lesions chosen for rotation were located as follows:

Oropharynx and hypopharynx.....	4
Middle ear.....	3
Nasopharynx.....	3
External auditory canal.....	1
Base of tongue.....	1
Hard palate.....	1
Base of skull metastasis (1° salivary gland)....	1
Sphenoid-ethmoid sinuses.....	1

Five patients had had previous treatment. Definitive surgical procedures had been attempted in the carcinoma of the sphenoid-ethmoid sinuses and on one of 2 cases of non-chromaffin paraganglioma of the middle ear. Two cases had had previous x-ray therapy. One patient with a nasopharyngeal carcinoma had under-

gone a full course of radiation by fixed port technic. A recurrence five months later was retreated by rotation. The average tumor dose which this group of patients received was 5,800 r in five and a half weeks. The average port size was 5.5 cm. wide \times 7 cm. in height. All of the patients save one tolerated treatment excellently. This particular patient, with an extensive tumor of the oropharynx, received a tumor dose of 5,000 r in thirty-six days. He required tracheotomy at the end of treatment and died two months later. In none of the patients did a moist desquamation develop or were there untoward sequelae other than that mentioned in connection with the oropharynx case.

Six patients received subsequent therapy. One patient with carcinoma of the posterior pharyngeal wall required a partial resection of that area three years later and eventually received additional supervoltage radiation. He is still alive with disease fifty-six months after the initial treatment. One patient with a non-chromaffin paraganglioma of the petrous pyramid extending into the sella and sphenoid sinus was subsequently treated by external therapy on the betatron and is alive with disease

twenty-six months after rotation therapy. The cylindroma involving the base of the skull also received subsequent treatment, which again was accomplished by rotation therapy. Figure 1 demonstrates the survival of these patients.

ESOPHAGUS

Thirty-four patients with carcinoma of the esophagus at all levels were accepted

take into account the increased transmission due to interposed lung tissue, was 5,000 r in five weeks. This would mean that the actual dose was in the range of 5,600 r in five weeks. The average port size was 7 cm. wide \times 12 cm. high. The patients in general tolerated treatment well. In only 3 did esophagitis of a severe degree develop, and this cleared promptly. A moist desquamation on the anterior

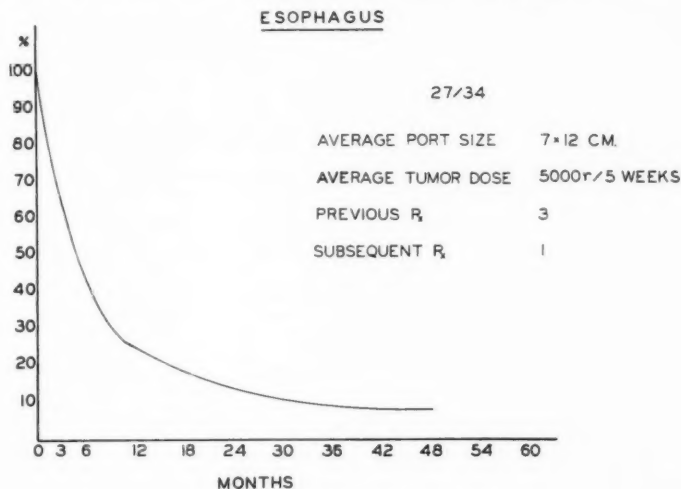


Fig. 2. Cumulative survival curve of 27 patients with carcinoma of esophagus.

for treatment. Twenty-seven were selected for rotation. Patients were not rotated if their poor physical condition indicated that they probably could not complete treatment or if they could not sit erect in the rotation chair. They were also rejected if large metastases were present in contiguous nodes or structures which would necessitate a treatment field whose diameter was greater than 10 cm. The few cases of carcinoma of the lower third of the esophagus that are irradiated are considered to be cases of fundal cancer. A relatively large volume must be treated.

Three patients had had previous treatment (Fig. 2). Two of these had surgical resections three and thirty-six months, respectively, before rotation. The third patient was treated twenty-six months earlier by intracavitary radium. The average calculated tumor dose, which did not

chest wall occurred in 4 of the 27 patients. In analyzing these cases it was found that in those with the moist desquamation the tumor was relatively near the anterior skin surface.

In 4 patients late sequelae developed. Radiation reaction of the lungs occurred in 2 patients, each of whom had received a calculated dose of 5,300 r in five weeks. In 1 case the change was purely a radiographic one without symptoms. The second case of pulmonary reaction developed in a seventy-five-year-old man two months after conclusion of irradiation. The decrease in pulmonary reserve contributed to his demise. One patient had a late esophagitis, and a fourth a tracheoesophageal fistula. Both had received a tumor dose of 4,800 r in five weeks. The latter patient had been treated by intracavitary radium. One cannot be certain that the

late esophagitis and the development of the fistula were not due to persistence or recurrence of tumor.

Figure 2 demonstrates the manner in which our patients survived. The curve was calculated according to the method of a cumulative survival curve. However,

(Fig. 3). One had had a pneumonectomy eighty-four months before rotation therapy and 2 had had lobectomies thirty-six months and eighteen months previously. The average calculated dose was 5,000 r in five weeks, the actual dose being approximately 5,600 r in five weeks, due to

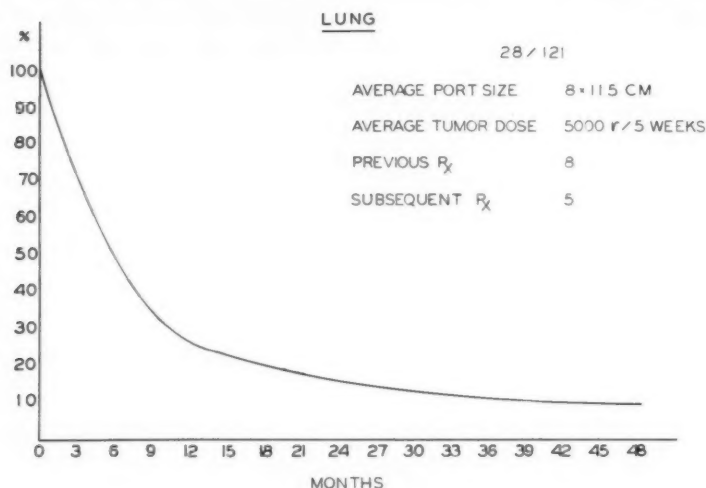


Fig. 3. Cumulative survival curve of 28 patients with carcinoma of lung.

since only 27 cases are presented, we do not mean to imply that this curve actually represents the manner in which a large population of patients with esophageal cancer would fare with this method of treatment. Four patients are alive at forty-nine, fifteen, thirteen, and nine months after the completion of rotation therapy.

LUNG

One hundred and twenty-one patients with carcinoma of the lung were treated by radiation during the past six years. Twenty-eight of these cases were selected for rotation therapy. Those excluded were in poor physical condition or had a primary lesion of such a size that the width of the port required would be too great for effective rotation therapy by this technic (over 10 to 11 cm.).

Previous definitive surgical procedures had been performed on 5 of the 28 patients

transmission through lung. The average port was 8 cm. wide × 11.5 cm. high.

Moderate esophagitis developed in 5 patients. In all cases, however, this difficulty disappeared soon after the conclusion of treatment. In 2 patients in whom a moist desquamation developed, the proximity of the axis of rotation to the skin appeared to be the important factor.

Postirradiation sequelae occurred in 6 patients: 3 had a pulmonary radiation reaction and 3 tracheoesophageal fistulae. Two of the patients incurring pneumonitis had received a calculated dose of 5,000 r in five weeks and 1 had received 6,000 r in six weeks. Tumor was presumably present in those patients in whom fistulae developed.

Five patients received subsequent radiotherapy. In 3 instances the primary area was retreated.

Figure 3 demonstrates the survivals

in this group. It was calculated in the manner of a cumulative survival curve, but is simply a diagrammatic representation of how our 28 patients fared. Two are alive, both at four years and three months. One of them had had a previous pneumonectomy and was treated for a proved recurrence in the bronchial stump.

at the time of radical hysterectomy. Three patients had a simple hysterectomy for a non-malignant condition. In these tumor was found in the cervix at operation. Six patients with cancer of the fundus treated by hysterectomy alone proved to have invasion of the blood vessels and/or lymphatics on histologic study. The aver-

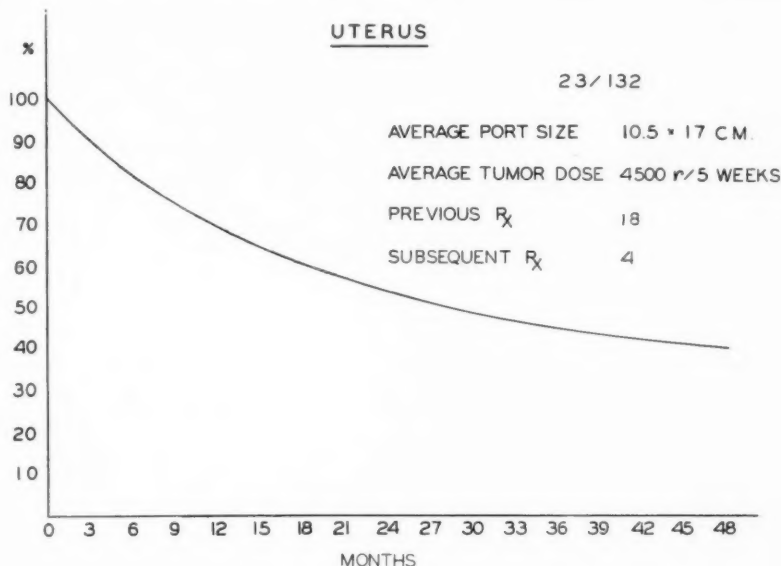


Fig. 4. Survival, in months, of 23 patients with carcinoma of uterus.

UTERUS

Of the 132 cases of carcinoma of the uterus treated by radiotherapy, 23 were selected for rotation therapy. Excluded from this series were routine stage I, II, and III patients who were primarily treated by radium and external irradiation through fixed ports to the parametrial regions. One Stage II patient, in whom a bulky tumor prevented visualization of the external os, received rotation therapy before a routine radium application. A patient with a Stage III lesion of the cervical stump was similarly treated. Seventeen patients had cervical and 6 fundal cancer. Included in the series are 18 cases primarily treated by surgery (Fig. 4). Nine of these were cervical carcinomas with positive lymph nodes found

age tumor dose was 4,500 r in five weeks. The average port was 10.5 cm. wide × 17 cm. high.

In general, the patients tolerated the treatment well, although those who had previously had radical hysterectomies did not do as well as the others. These patients received a dose lower than average. In 2 of them severe proctitis developed, and there was one case of cystitis. In the latter patient the bladder was invaded by tumor.

Late untoward effects included persistent diarrhea in 2 patients, 1 case of vesicovaginal fistula, and 1 of radiation necrosis of the hip developing one year later. The fractured neck of the femur had received 3,800 r.

Subsequent treatment was given to 4

patients. In 1 with fundal carcinoma, who received 5,000 r in seven weeks, nodules appeared in the vagina two years later. Retreatment in this case consisted of delivering, *via* vaginal cone, 3,000 r in one week to these nodules. This patient is still alive four years after the initial treatment.

In the patient with Stage III carcinoma

BLADDER

Seven patients with extravescical extension of tumor to the lateral pelvic walls were among the 11 selected for rotation therapy out of 86 patients with bladder and prostatic carcinoma. Two others had extensive invasive carcinoma of the bladder and were chosen for rotation during a brief period when total cystectomy was

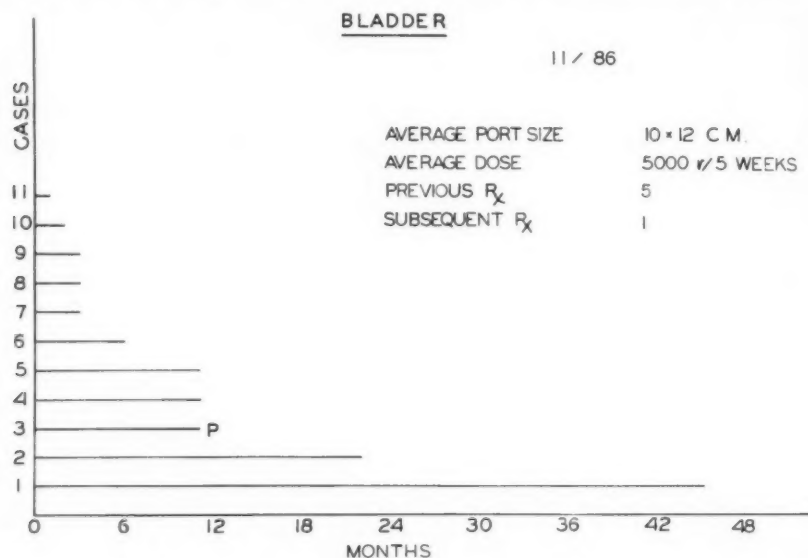


Fig. 5. Survival, in months, of 11 patients with carcinoma of bladder.

of the cervical stump metastatic lesions were discovered in the pelvic bones twenty-one months later. These were treated by external irradiation. The patient died three and a half years after rotation therapy.

Of the 23 patients, 2 are alive at thirteen and fifteen months, 5 are alive at twenty-four and thirty months, 2 at thirty-two and thirty-three months, and 3 at four and five years. In these surviving patients there are only two carcinomas of the fundus. Since all of the fundal cases showed vascular invasion, this low survival rate is not surprising. Such patients uniformly do badly. Of the 9 who had radical hysterectomies, 2 have died, 1 at ten and 1 at eleven months.

rarely considered on the Urologic Service. One patient had an extensive invasive carcinoma of the bladder and an associated adenocarcinoma of the prostate. One had a leiomyosarcoma of the prostate without distant metastasis.

The favorable, small bladder lesions were treated by radium or radon seed implantation. Excluded from consideration for rotation were patients with disease outside the true pelvis, those who had evidence of direct extension to bone, those who were greatly debilitated, and those in whom radium was applied intravesically, for palliation, by the central source technique of Lewis and Friedman for control of bleeding.

Five of the patients had been treated

previously (Fig. 5). Four had undergone surgical procedures, including 2 total cystectomies, 1 transurethral resection, and 1 extensive fulguration. In 1 case fulguration and radium implantation had been performed four years prior to rotation therapy.

The average tumor dose was 5,000 r in five weeks. The usual port size was 10 X

PITUITARY ADENOMAS

Sixteen patients with pituitary adenomas and 8 patients with Cushing's syndrome received radiotherapy over the six-year period. All of these patients save 1 with a pituitary adenoma received rotation therapy. It is our feeling that this method is eminently suitable for the treatment of pituitary lesions.

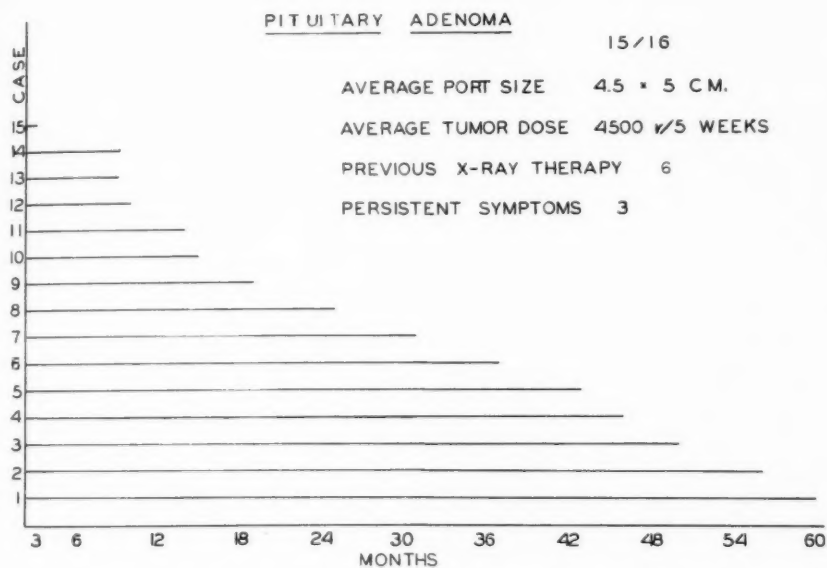


Fig. 6. Follow-up, in months, of 15 patients with pituitary adenomas. Five patients had previous surgery.

12 cm. All tolerated their treatment well. The expected incidence of cystitis was observed. In 1 patient a moist desquamation developed after 5,000 r in five weeks. None had sequelae which could not be explained by persistence of the tumor. One patient with an invasive tumor at the base of the bladder received 4,500 r in four weeks by rotation therapy, followed by the implantation of radon seeds. Treatment was done in this manner because the patient had a recent coronary occlusion and operation was therefore delayed. Figure 5 demonstrates how these individual patients fared. All are dead of cancer.

Five of the adenoma patients had undergone surgery, including partial resection of the tumor or decompression of a cyst. Six had had one or two previous courses of radiation delivered through fixed ports. The average tumor dose was 4,500 r in five weeks. The average port size was 4.5 X 5.0 cm. with little variation from this. All patients tolerated treatment extremely well and no moist desquamations occurred. Little other than transient tanning and alopecia was observed. In 3 patients panhypopituitarism developed. Two of these had had previous radiotherapy and 1 previous surgery.

All the patients were alive and well on

TABLE 1: SEVENTEEN MISCELLANEOUS LESIONS RECEIVING ROTATION THERAPY

Diagnosis	Site	Dose/Time	Port Size	Previous Treatment	Response	Subsequent Treatment	Survival Time or Period Before Retreatment
1. Hyperthyroidism with exophthalmos	Pituitary	3,000 r/3 weeks	4 × 4 cm.	Antithyroid medication	No improvement	Thyroidectomy after 11 months	11 months
2. Breast carcinoma	Pituitary	6,500 r/6 weeks	4 × 5 cm.	Testosterone	Improved for one year	None	1 year, 3 months*
3. Breast carcinoma	Pituitary	5,000 r/5 weeks	4 × 4 cm.	Testosterone	Improved for 10 months	Hypophysectomy 14 months after treatment	1 year, 2 months*
4. Craniopharyngioma	Pituitary-sella turcica	5,000 r/5 weeks	4 × 4 cm.	Partial resection	No benefit	Total excision of cyst 7 months after treatment	7 months
5. Craniopharyngioma	Pituitary-sella turcica	5,500 r/5 weeks	5 × 5 cm.	Partial resection	? Possible benefit	Decompression necessary 4 months after treatment	4 months
6. Optic nerve glioma	Optic chiasm	5,500 r/6 weeks	5 × 5 cm.	None	Lesion controlled	None	3 years, 11 months
7. Destructive lesion (no tissue diagnosis)	2nd cervical vertebra	5,000 r/7 weeks	5 × 7 cm.	None	? Unimproved	None	6 months*
8. Fibromatosis	Cervical esophagus	3,000 r/3 weeks	6 × 7 cm.	None	Improved	None	4 years, 1 month
9. Carcinoma of larynx	Esophagus, metastatic	3,000 r/3 weeks	6 × 8 cm.	Laryngectomy	No improvement	None	1 month*
10. Carcinoma of larynx recurrent in trachea	Trachea	4,000 r/7 weeks	6 × 6 cm.	Laryngectomy 2 years 3 months before x-ray treatment	No improvement	None	1 month*
11. Hemangioperithelioma	Mediastinum	2,000 r/3 weeks	10 × 10 cm.	Three previous courses of x-ray therapy	Fair	None	1 year*
12. Lymphosarcoma	Mediastinum	2,000 r/2 weeks	8 × 10 cm.	None	Poor	X-ray therapy for recurrence in 2 months	2 months*
13. Breast carcinoma metastasis	Mediastinum	3,000 r/3 weeks	10 × 15 cm.	None	Fair	None	6 months*
14. ? Breast carcinoma	Mediastinum	5,000 r/5 weeks	8 × 18 cm.	Lobectomy	Improved	None	19 months*
15. Sigmoid carcinoma	Esophagus and mediastinum	5,000 r/5 weeks	6 × 9 cm.	None	Poor	None	2 months*
16. Carcinoma of rectum	Pelvis	6,000 r/7 weeks	9 × 15 cm.	None	Good response; postoperative death 1 year 5 months after treatment	None	1 year, 5 months*
17. Carcinoma of colon	Pelvis	4,500 r/4 weeks	10 × 10 cm.	Resection of recto-sigmoid	Fair	None	11 months*

* Indicates death of patient.

Oct. 15, 1957. The patients at sixty months, forty-six months, and thirty-one months postirradiation have had recurrence of some symptoms, though to this date it had not been felt necessary to retreat them (Fig. 6).

Patients with Cushing's syndrome or Cushing's disease were given pituitary irradiation as a primary procedure when it was considered that the underlying difficulty was adrenal hyperplasia or pituitary basophilism. Pituitary irradiation was not used if a tumor of the adrenal was suspected on retroperitoneal air studies. Three of the 8 patients are free of symptoms, 1 at five years, 1 at four years, and 1 at twelve months. Three patients had had previous partial adrenalectomies with persistent symptoms. Two of these are symptom-free four and five years after pituitary irradiation. No patients have died. Treatment is similar to that given for pituitary adenomas.

MISCELLANEOUS GROUP

Seventeen patients with various problems were treated by rotation therapy. Five of these patients had treatment to the pituitary region. Two with craniopharyngiomas showed no improvement. Two were patients with advanced breast cancer who had done well for several years on testosterone therapy but had now escaped from the effects of the hormone. They were rejected for adrenalectomy because they were considered to be in a terminal condition. Each of these patients received rotation therapy to the pituitary gland; one 6,500 r in six weeks and the other 5,000 r in five weeks. Both improved, one remaining well for one year and the second for ten months. There was no improvement following pituitary irradiation, 3,000 r in three weeks, in a patient with malignant exophthalmos.

A summary of these cases is seen in Table I. Case 8, fibromatosis of the cervical esophagus, is of special interest. Repeated biopsies in this patient had shown no evidence of malignancy. Her pharynx and cervical esophagus were so constricted

that swallowing was difficult. A dose of 3,000 r was delivered in three weeks through a 6 x 7-cm. port. Improvement was rapid and the patient has remained well four years and one month. Of 2 patients with carcinoma of the rectum, 1 was given 6,000 r in seven weeks via a 9 x 15 cm. port and had an excellent response. Because of no evidence of disease seventeen months later, a colostomy performed previous to radiation was to be closed. Unfortunately, this patient died on the operating table during the procedure.

SUMMARY AND CONCLUSION

1. Rotation therapy utilizing standard deep-therapy generators was readily applicable to 15 per cent of patients accepted for treatment in the radiotherapy department of a general hospital.

2. From experience with 144 such patients, it was found that the chief areas in which this type of equipment finds application are the head and neck, esophagus, lung, uterus, bladder, and pituitary fossa.

3. Accurate localization of the lesions for rotation therapy is no more time-consuming than for multiple-port technic.

4. This procedure permits the delivery of satisfactory tumor doses with a relatively low incidence of untoward reactions: moist desquamation in 9 of the 144 cases; sequelae of significance in 13; complications during treatment (dyspnea, esophagitis), in 12, though only 2 patients failed to complete treatment.

5. While we are unable to claim an improvement in survival because of the small numbers treated, rotation therapy is considered a valuable technic for both definitive therapy and palliation and has proved to be the treatment of choice in many patients.

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REFERENCE

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SUMMARIO IN INTERLINGUA

Therapia Rotational A Orthovoltage: Sex Annos De Experientia In Un Hospital General

Ab un gruppo de 1.165 patientes con neoplasma maligne, plus 24 con adenoma pituitari, 144 esseva seligite pro therapia rotational con generatores de therapia profunde de typos standard. Le rotation non esseva necessariamente complete. Technicas percursive e combinatemente percursive e fixe esseva utilisate quando illos pareva esser indicate.

Esseva trovate que le major areas in que iste typo de tractamento es applicate es le capite e le collo, le esophago, le pulmon, le utero, le vesica, e le fossa pituitari.

Le technica permette le application de doses satisfactori al tumor, con relative-mente basse incidentia de reactiones ad-

verse. Desquamation humide sequeva le irradiation in 9 del 144 casos, sequellas de signification occurreva in 13, e complicationes durante le tractamento (dyspnea, esophagitis) in 12, sed le tractamento esseva interrumpite ante su completion in solmente 2 casos.

Ben que il non es possibile, super le base de iste micre serie, asserer que un melioration del superviventia esseva effectuate, le technica del irradiation rotational pote esser considerate como utile in le tractamento definitive e etiam pro objectivos de palliation. In multe casos illo has essite recognoscite como le tractamento de election.



Disseminated Indeterminate Pulmonary Disease

Value of Lung Biopsy¹

MARK H. WHOLEY, M.D., C. ALLEN GOOD, M.D., and JOHN R. McDONALD, M.D.

Forty or fifty years ago the roentgenologic picture of disseminated pulmonary disease usually was thought to mean tuberculosis. Since that time many other causes have been recognized, and an awareness of the wide variety of conditions which produce this picture has grown rapidly in the past quarter of a century. In 1938, for example, King (1) catalogued 10 possible causes, in 1942 Austrian and Brown (2) enumerated 22, in 1948 Felson and Heublein (3) counted 75, and by 1952 Scadding (4) had raised the figure to 80. For purposes of classification the numerous conditions may be subdivided into seven groups: infections, inhalations, aspirations, vascular diseases, systemic diseases and pulmonary diseases of uncertain etiology, neoplasms, and allergies.

With the growing recognition of the many entities producing a roentgenologic appearance of disseminated pulmonary disease has come the realization that the information gained from the clinical history, the physical examination, and the routinely available laboratory procedures is often insufficient to provide a definite diagnosis. Surgical procedures designed to obtain tissue for histologic, bacteriologic, and chemical examination have been employed, including bronchoscopic biopsy, biopsy of the scalene group of lymph nodes, and direct biopsy of the lung.

Biopsy of the lung is seldom used unless all other means have failed to provide a diagnosis. Pulmonary tissue may be obtained in several ways; for example, by needle biopsy, by the limited biopsy procedure described by Klassen (5), and by means of formal thoracotomy. Needle

biopsy is hazardous, sometimes causing hemorrhage or pneumothorax, and frequently it fails to furnish sufficient material for adequate examination (6). The limited biopsy of Klassen, employing a small intercostal incision, usually in the third or fourth interspace anteriorly on the right, provides an adequate specimen and accessibility to all portions of the right lung. Formal thoracotomy has the added advantage of allowing gross inspection of the entire lung, thereby insuring that tissue will be obtained from the most advantageous site.

In a limited number of cases, therefore, biopsy of the lung provides a definite diagnosis which is useful in planning treatment, in determining prognosis, and in solving the medicolegal problems of patients subjected to occupational hazards.

At the Mayo Clinic, from Jan. 1, 1950, to Dec. 31, 1955, biopsy of the lungs was employed in 34 cases of disseminated pulmonary disease. In each instance the results of other methods of diagnosis had been inconclusive, including 17 cases in which exploration of the scalene group of lymph nodes had given negative results. In all 34 cases tissue was obtained by formal thoracotomy. The tissue was examined histologically after routine and special staining procedures; it was cultured for bacteria, fungi, and viruses whenever such procedures were indicated, and it was subjected to chemical analysis in appropriate instances. The 34 cases were classified as to diagnosis as follows: Group 1, idiopathic diffuse interstitial fibrosis, 9 cases; Group 2, granulomatosis, 14 cases, including 1 of Wegener's granulomatosis, 3 of histiocyto-

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TABLE I: IDIOPATHIC DIFFUSE INTERSTITIAL FIBROSIS

Case	X-ray Findings	Volume of Lung Involved, Graded 1 through 4*	Cyanosis	Congestive Failure
1	Progressive dense linear fibrosis in both lower lung fields	2	Yes, on exertion	No
2	Linear and nodular fibrosis in both lower lung fields	2	Yes	No
3	Reticular and finely nodular fibrosis throughout the greater part of both lung fields. Cardiomegaly	4	Yes	No
4	Finely nodular and reticular linear fibrosis in the middle and central lung fields	3	No	No
5	Dense linear fibrosis in both lower lung fields	3	Yes, on exertion	Yes
6	Dense linear interstitial fibrosis throughout the greater part of both lung fields	4	No	No
7	Diffuse and dense linear and miliary nodular fibrosis throughout the greater part of both lung fields. Cardiomegaly	4	Yes, on exertion. Secondary polycythemia. Pulmonary osteoarthritis	Yes
8	Diffuse linear interstitial fibrosis throughout the greater part of both lung fields	4	Yes. Secondary polycythemia	No
9	Bilateral diffuse interstitial fibrosis with areas of honeycombing. Cardiomegaly	4	Yes	Yes

* Grade 1 indicates the least involvement and grade 4 the greatest involvement.

sis, 5 of sarcoidosis, 2 of bacterial disease (tuberculosis), and 3 of fungous diseases; Group 3, neoplasm, 5 cases; and Group 4, chronic pneumonitis, nonspecific, 6 cases.

IDIOPATHIC DIFFUSE INTERSTITIAL FIBROSIS (GROUP 1)

Acute diffuse interstitial fibrosis of the lung was described in 1944 by Hamman and Rich (7), who suggested that the clinical features and pathologic changes manifested by their 4 cases constituted a separate clinical entity. Briefly, the Hamman-Rich syndrome is characterized by unremitting, progressive dyspnea and paroxysmal unproductive cough, leading to death by suffocation. In some instances, hemoptysis, cyanosis, clubbing of the fingers, and polycythemia may be noted. At necropsy the

lungs are found to be voluminous and heavy, and sink when placed in water. The pleural surfaces are uninvolved or may show small depressed scars enclosing tiny blebs. On gross section, the lungs are dry, firm, and granular, with a lacy network of fine fibrous strands. Microscopic study shows diffuse fibrosis of the interstitial tissue, resulting in thickened alveolar septa. Usually an interstitial cellular exudate is present, composed of eosinophils, plasma cells, and lymphocytes. No stainable organisms can be found. Two other features which usually are present are metaplasia of the cells lining the alveoli and intimal or subintimal thickening of the pulmonary arterioles (8) (Fig. 1, b).

Although many etiologic agents have been proposed for the Hamman-Rich syn-

TABLE II: DIFFUSE INTERSTITIAL FIBROSIS: PATHOLOGIC FACTORS

Case	Inter- stitial Diffuse Fibrosis*	Inter- stitial Cellular Exudate*	Hyaline Membrane	Alveolar Lining Meta- plasia*	Vascular Intimal and Subintimal Thickening*	Alveolar Exudate
1	4	1	+	4	4 Arterioles Arteries	-
2	4	2	+	3	4 Arterioles	+
3	3	3	-	2	0	-
4	4	1	+	2	2 Arterioles	-
5	2	1	-	2	2 Arterioles	+
6	4	2	-	4	2 Arterioles	-
7	4	1 Minimal	+	3	2 Arterioles	-
8	3	1 Minimal	+	1	4 Arterioles	-
9	4	1	-	3	3 Arterioles	-

* Graded 1 to 4, with 1 representing the least amount and 4 the greatest amount.

drome, such as viruses, rickettsia, and certain chemical irritants, the exact cause of the condition is unknown. Some authors propose that the pathologic changes are the results of repeated attacks of pneumonitis or of a nonspecific reaction of the host to numerous and sundry agents (9-13).

In 9 of our 34 cases pathologic changes seemed to indicate the presence of idiopathic diffuse interstitial fibrosis of the lung. Because in certain features these cases varied somewhat from those originally described by Hamman and Rich, we prefer this more descriptive term to "Hamman-Rich syndrome." The clinical and roentgen features of these 9 cases are shown in Table I and the pathologic features in Table II.

The roentgen features of idiopathic diffuse interstitial fibrosis as demonstrated by our cases follow: (a) Diffuse involvement of both lungs is evident (Fig. 1, a). Early in the course of the disease the changes were located centrally and resembled those seen in azotemic pneumonitis and in certain of the collagen diseases. Later there was

extension to the periphery and the basilar regions. There was no involvement of the apices in most instances. (b) Hilar adenopathy and significant pleural reaction are absent. (c) Fibrosis is present, first as a fine reticular pattern and later as confluent shadows, especially in the bases of the lungs. In some cases the reticular pattern changed to one showing small or miliary nodules. (d) Emphysema became more marked as the disease progressed. (e) Cor pulmonale was present in only 2 of the 9 cases and was associated with extensive involvement of the parenchyma of the lungs.

In this group the roentgenologic appearance of idiopathic diffuse interstitial fibrosis was confused oftenest with that of pneumoconiosis, azotemic pneumonitis, and sarcoidosis.

As mentioned before, we prefer the term "idiopathic diffuse interstitial fibrosis" to "Hamman-Rich syndrome." The cases reported by Hamman and Rich were rapidly progressive and ended in death within a few months. Although the pathologic fea-

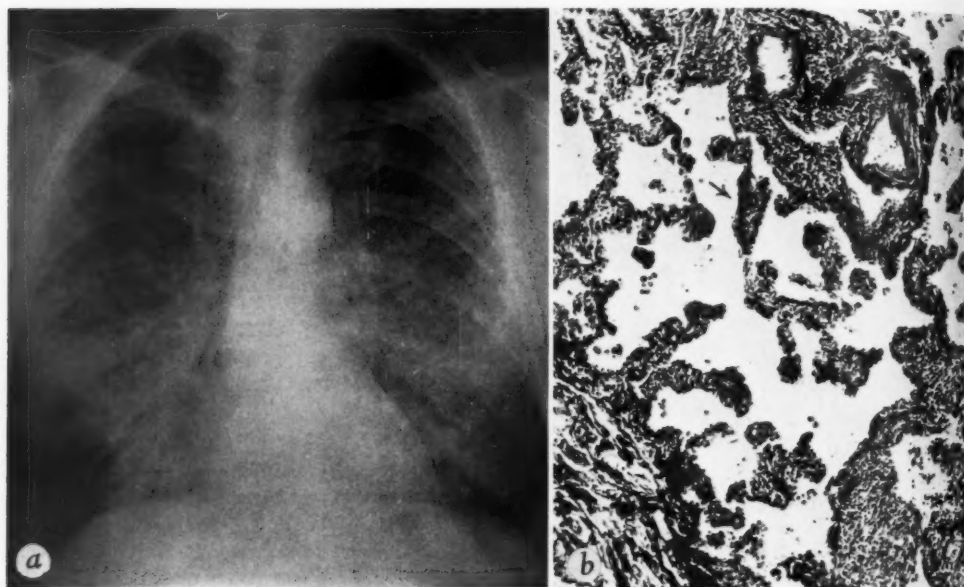


Fig. 1. Idiopathic diffuse interstitial fibrosis (Hamman-Rich syndrome). *a.* Roentgenologic appearance. *b.* Thickening of alveolar septa, interstitial cellular infiltrate, intimal and subintimal thickening of smaller pulmonary vessels and hyaline membrane lining the alveoli (arrow). van Gieson's stain. $\times 90$.

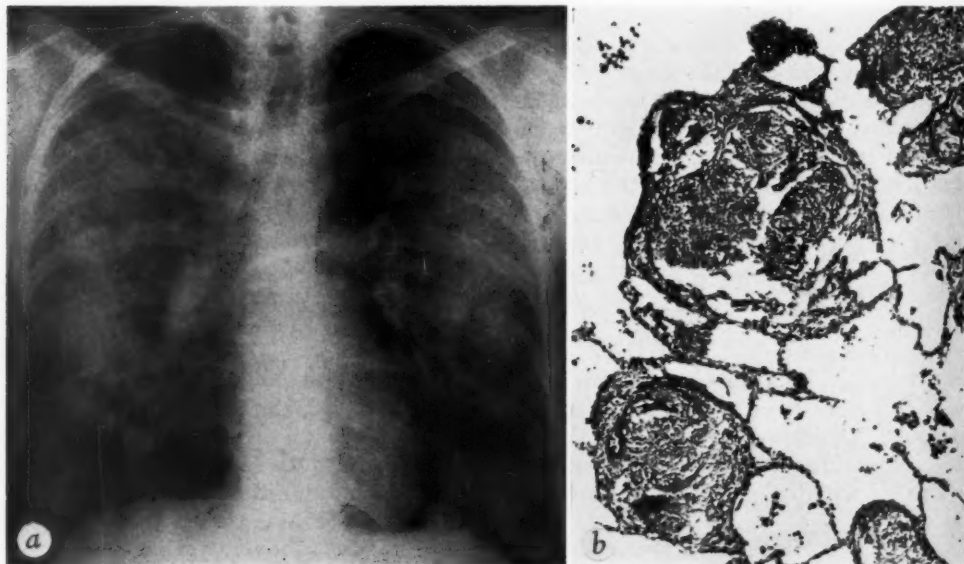


Fig. 2. Sarcoid. *a.* Roentgenologic appearance. *b.* Noncaseating granulomas with giant cells. Remaining pulmonary parenchyma is uninvolved and relatively normal in appearance. Hematoxylin and eosin. $\times 80$.

tures in our series were similar to those which they described, the clinical course in several instances was much more prolonged. One of our patients, for example,

is still alive twelve years after the first symptoms. Peabody, Buechner, and Anderson (14) have studied a patient who lived at least nine years after onset of the

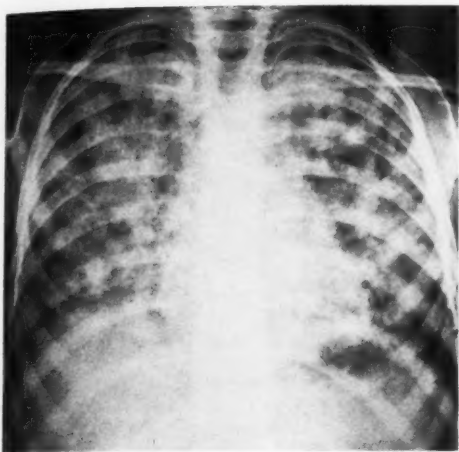


Fig. 3. Aspergillosis involving the lungs of a child seven years of age.

disease. Certainly this long period of survival does not correspond to the acute clinical course originally described by Hamman and Rich; yet the morphologic picture was similar in all respects to that which they reported. Consequently we feel that the diagnosis must be established on clinical grounds and that there are acute and chronic forms of the disease.

GRANULOMATOUS DISEASES (GROUP 2)

Fourteen of the 34 cases in which the diagnosis was made by biopsy of lung tissue belonged in the group of granulomatous diseases. Five were thought to be examples of sarcoidosis, 2 of tuberculosis, and 3 of fungous infection. In each instance the roentgen appearance was one of diffuse involvement of both lungs, with regions of confluent and linear fibrosis, sometimes associated with patches of pneumonitis (Fig. 2, *a*). In some cases there seemed to be a tendency toward nodularity. In no instance was a definite diagnosis possible by the more usual procedures of bacteriologic, mycologic, and cytologic examination of the sputum and gastric content, or biopsy of the scalene group of lymph nodes.

In the cases of sarcoidosis the histologic appearance of the tissue removed from the lung was that of a noncaseating granuloma associated with giant cells, thickening of the intima of the arterioles, and minimal amounts of interstitial fibrosis (Fig. 2, *b*). Cultures of this tissue for fungi and bacteria were sterile.

The diagnoses in the 3 cases of fungous disease and in 1 case of tuberculosis were

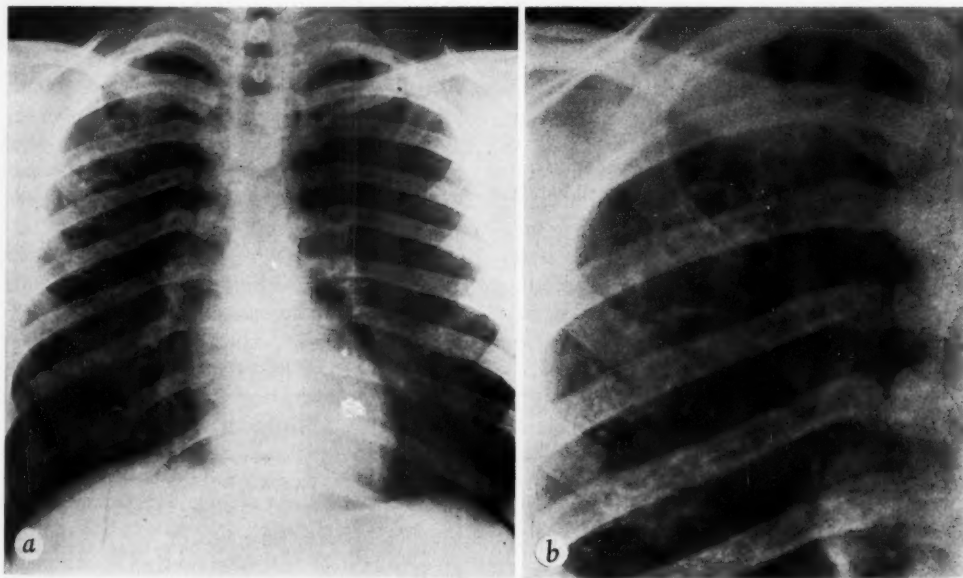


Fig. 4. Histiocytosis (eosinophilic granuloma). There is a small pneumothorax on the right. The honeycomb appearance is well demonstrated in *b*.

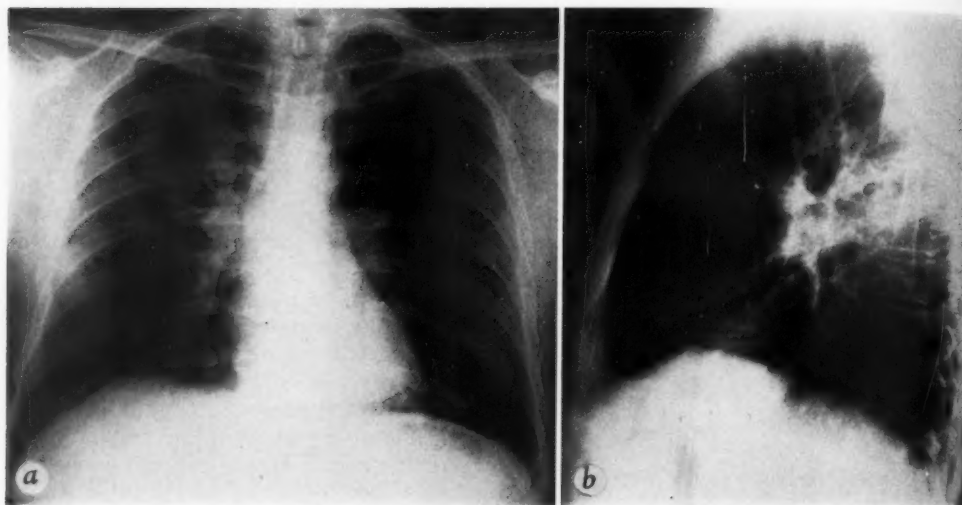


Fig. 5. Wegener's granulomatosis. Both lungs contain several well circumscribed nodules.

based on the recovery of the following organisms from cultures of lung tissue: *Aspergillus fumigatus* in 2 cases (Fig. 3), *Histoplasma capsulatum* in 1 case, and *Mycobacterium tuberculosis* in 1 case. In the other case diagnosed as tuberculosis, cultures were negative, but the histologic appearance was thought to be typical.

Included in the group of granulomatous diseases were three cases of histiocytosis. The term "histiocytosis" is now recommended to encompass such conditions as eosinophilic granuloma, Letterer-Siwe disease, and Hand-Schüller-Christian disease, inasmuch as these entities are thought to be merely stages of the same fundamental process (15-17). Apparently the essential disturbance is an expansion in the reticulo-endothelial system, and all organs including bone, liver, splenic lymphatics, and lungs may be involved singly or in combination. Although the honeycomb pattern noted in conventional thoracic roentgenograms is not pathognomonic of histiocytosis, it appeared with such uniformity and distinction in our group of cases that we feel its presence should suggest that diagnosis as a first consideration (Fig. 4). Similar but less marked or distinctive changes have been noted in tuberous sclerosis, bronchiectasis,

bronchiolitis, and long-standing asthmatic bronchitis (17).

The mechanism for the production of the honeycomb effect has not been determined, but several theories have been proposed (16-19). We are of the opinion that the changes noted in roentgenograms of the lungs develop in stages and are analogous to the histologic alterations noted at biopsy.

Stage 1: The histiocytic proliferation and granulomatous reaction that occur within the interstitial substance of both lungs result early in a finely reticular appearance throughout the lung fields. It is at this cellular stage that remissions following therapy are most likely to occur. This reticular process, because of its distribution throughout the interlobular septa and reticuloendothelial apparatus, results in small annular shadows with a honeycomb effect.

Stage 2: With continuing interstitial cellular proliferation and gradual replacement by fibrosis, the bronchioles are weakened and subsequently cysts form. In addition, the bronchioles may be compressed by fibrosis, with the production of alveolar dilatation distal to the partial obstruction. If the obstruction is complete, with subsequent alveolar collapse, a com-

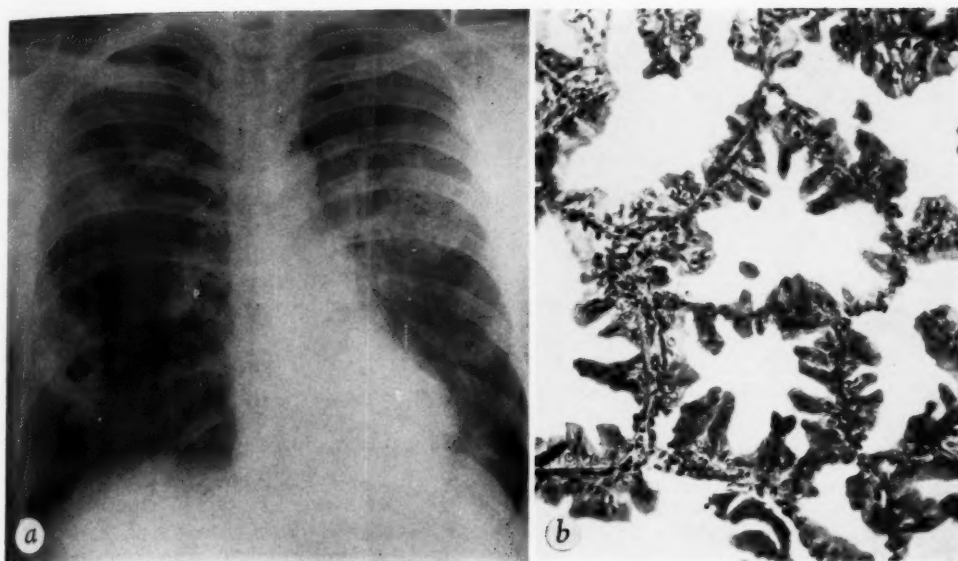


Fig. 6. Alveolar-cell tumor. *a.* Roentgenogram shows disseminated disease process with evidence of a cavity in the right lung. *b.* Tall columnar cells with papillary projections lining the alveoli. Hematoxylin and eosin. $\times 180$.

bined cystic and miliary nodular appearance may predominate, exaggerating the honeycomb effect. Spontaneous pneumothorax is a common complication in this late fibrotic stage (19).

Finally, among the granulomatous diseases, we have included 1 case of Wegener's granulomatosis. In 1939, Wegener (20) described this syndrome characterized clinically by sinusitis, necrotizing granulomas of the upper and lower respiratory tract, renal insufficiency, arthralgia, and diffuse vasculitis. Since that time, 27 cases have appeared in the literature which is available to us.

In the following case the diagnosis was established by histologic examination of tissue obtained from the lungs and kidneys for biopsy.

A 46-year-old farmer was well until April 1955, at which time he experienced a sudden onset of dyspnea and pain in the anterior portion of his thorax, accompanied by fever, which reached as high as 100°F . Two months later he was examined at the Clinic. He also gave a history of chills, night sweats, cough, and hemoptysis. He had lost 20 pounds.

Roentgenograms of the thorax, July 28, 1955,

showed several well circumscribed nodular lesions in both lungs (Fig. 5), which appeared similar to metastatic nodules, and were so reported by the roentgenologist. Roentgen examinations of the gallbladder and upper portion of the gastrointestinal tract did not reveal evidence of disease. An excretory urogram showed poor concentration of the medium in both kidneys. The urea nitrogen ranged between 165 and 138 mg. per 100 c.c. of blood. The erythrocyte sedimentation rate was 129 mm. in the first hour (Westergren). Albumin and casts containing red and white blood cells were found in the urine. Examination of the sputum did not reveal acid-fast bacilli, fungi, or malignant cells. Tests of skin sensitivity to the antigens of tuberculosis and histoplasmosis also gave negative results.

On July 30, the right supraclavicular space was explored, but no pathologic lesions were evident in the nodes which were removed. On Aug. 2, a lung biopsy showed evidence of a caseating granuloma. Needle biopsy of one kidney was undertaken later, and the histologic picture was that of diffuse glomerulonephritis. In spite of treatment with prednisone (Meticorten) and supportive measures, the patient died about ten months after the onset of symptoms.

The final diagnosis of Wegener's granulomatosis was based on the presence of granulomatous lesions in the lungs, renal insufficiency and diffuse glomerulonephritis, and evidence of arthralgia. Roentgenologically the pulmonary lesions resembled metastatic neoplasm but did not possess any general identifying characteristics.

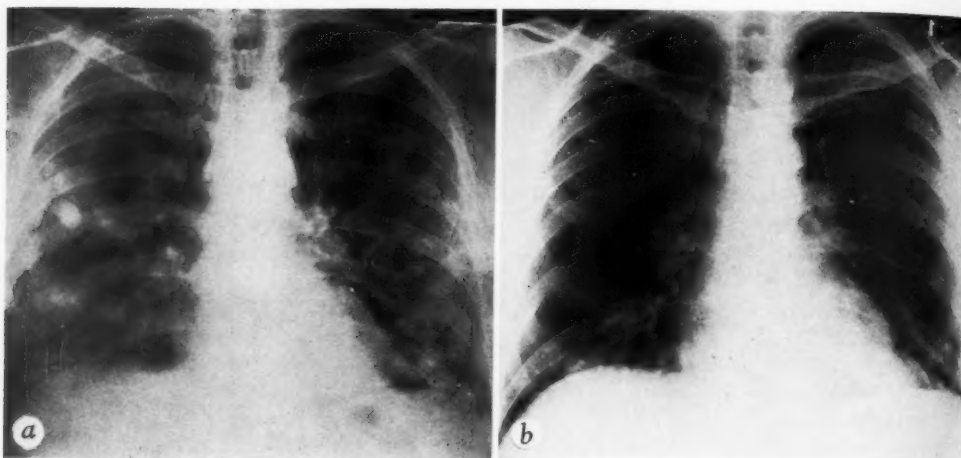


Fig. 7. Disseminated focal pneumonitis. *a.* Before lung biopsy. *b.* Fifteen weeks later, after treatment with antibiotics.

In most of the reported cases of Wegener's granulomatosis, the pulmonary lesions have been circumscribed; occasionally they have been cavitated (21). The etiology of this syndrome remains a matter of speculation. Because of the widespread vascular involvement, it is often considered a renal-respiratory subtype of periarteritis nodosa. Fahey and others (22) have suggested that the disease is one of hypersensitivity, in view of the combined occurrence of diffuse vasculitis, glomerulonephritis, and necrotizing pulmonary granulomas.

NEOPLASTIC DISEASES (GROUP 3)

In this series of indeterminate pulmonary disease there were 5 examples of primary and secondary neoplastic disease. Two of the cases represented metastatic carcinoma, 1 was an alveolar-cell carcinoma of the lung (Fig. 6), 1 a primary bronchogenic carcinoma, and 1 a chorio-adenoma destruens metastatic to the lung. In all except the last mentioned instance the results of bronchoscopic examination, cytologic examination of sputum, exploration of scalene nodes, and indicated laboratory examinations were negative. The principal value of biopsy of lung tissue in this group was to aid in establishing the prognosis as well as the diagnosis.

CHRONIC PNEUMONITIS (GROUP 4)

Group 4 was composed of 6 cases showing a variety of roentgenographic patterns of diffuse pulmonary disease. There were 2 examples of disseminated focal pneumonitis that resembled nodular metastatic neoplasm (Fig. 7). In both cases the disappearance of the lesions following therapy demonstrates the real value of biopsy of lung tissue for accurate histologic diagnosis. The remaining cases showed roentgenographic features of extensive interstitial pneumonitis. Histologically the alveoli and septa were obliterated by exudate and fibrosis. In all instances the results of routine diagnostic procedures were negative and biopsy was necessary for a rational approach to therapy and prognosis.

COMMENT

The value of biopsy of lung tissue in disseminated pulmonary disease is now well documented (23-25). In our own experience the procedure was of definite value, but only in a selected group of cases. This was particularly true in those diseases presenting disseminated nodular lesions clinically resembling metastatic neoplasm, but which, on histologic examination, were found to be a variety of granulomatous infiltrates and focal pneumonitis.

More specifically, biopsy of pulmonary tissue has provided us with material for correlation of the histologic and roentgenographic data with the clinical course. In the majority of instances a diagnosis can be established by means of the clinical history and physical examination supplemented by routine laboratory tests. In certain instances, more specialized studies may be required. These may include diagnostic surgical procedures such as exploration of the scalene group of lymph nodes. When these nodes are palpable, an accurate histologic diagnosis is possible in about 90 per cent of the cases. When they are not palpable, however, a specific diagnosis can be made in only about half of the cases. Unfortunately, the disseminated pulmonary diseases often do not manifest themselves in this group of nodes. In 17 of our patients exploration of scalene nodes yielded inconclusive results, and biopsy of lung tissue was necessary for an accurate diagnosis.

SUMMARY

Biopsy of lung tissue was carried out in 34 cases which were subdivided into four groups. The first group consisted of 9 cases of idiopathic diffuse interstitial fibrosis which satisfied the histologic criteria of Hamman and Rich. For these cases we prefer the term "idiopathic diffuse interstitial fibrosis" with acute and chronic stages to the term "Hamman-Rich syndrome." Furthermore, the dismal prognosis once associated with the condition should be modified, since in some cases it apparently follows a more benign course.

The second group was composed of the granulomatous diseases, subdivided as follows: Wegener's granulomatosis, histiocytosis, sarcoidosis, bacterial diseases, and fungous diseases. There were no identifying roentgen features for the circumscribed nodular lesions present in Wegener's granulomatosis. In addition to the pulmonary features, renal insufficiency, arthralgia, sinusitis, and midline facial granulomas may be present. Pulmonary involvement may be the only manifestation of histiocy-

tosis. Our 3 cases showed an identical roentgenologic feature: honeycomb lung. The remainder of the granulomatous group consisted of 5 cases of sarcoidosis, 2 of tuberculosis, and 3 of fungous disease (1 case of histoplasmosis and 2 cases of aspergillosis). Biopsy of the lungs was an important factor in determining the proper diagnosis in each case.

The third group was composed of neoplastic disease. In each instance of metastatic neoplasm, the parenchymal lesions in the lung were nodular and scattered.

The fourth or miscellaneous group comprised 6 cases of chronic pneumonitis showing a variety of patterns. In 2 cases of disseminated focal pneumonitis the roentgenologic appearance strongly resembled nodular metastatic neoplasm. Subsequent follow-up data revealed complete clearing of the process. Biopsy of lung tissue proved to be a valuable diagnostic aid in this group.

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SUMMARY IN INTERLINGUA

Indeterminate Morbo Pulmonar Disseminate. Valor De Biopsia Del Pulmon

Biopsias de histo pulmonar esseva effectuate in 34 casos, subdividite in quatro gruppos. Le prime gruppo consisteva de 9 casos de idiopathic diffuse fibrosis interstitial que satisfaceva le criterios histologic de Hamman e Rich. Le triste prognose olim associate con iste condition deberea esser modificate, proque in certe casos illo pare sequer un curso relativamente benigne.

Le secunde gruppo consisteva de casos de morbo granulomatose, subdividite sequentemente: Granulomatosis de Wegener, histiocytosis, sarcoidosis, morbos bacterial, e morbos fungose. Esseva constatate nulle specific characteristics roentgenographic pro le circumscripse lesiones nodular que es presente in granulomatosis de Wegener. Esseva presente—a parte le characteristics pulmonar—insufficiencia renal, arthralgia, sinusitis, e granulomas facial. Le affection pulmonar pote esser le sol manifestation de histiocytosis.

Le 3 casos in le presente serie exhibiva un identic characteristic roentgenographic: pulmon faveolate. Le resto del gruppo granulomatose consisteva de 5 casos de sarcoidosis, 2 de tuberculosis, e 3 de morbo fungose (1 de histoplasmosis e 2 de aspergillosis). Biopsia pulmonar esseva un factor importante in establir le correcte diagnoses.

Le tertie gruppo consisteva de casos de morbo neoplastic. In omne le casos de morbo metastatic, le lesiones parenchymal in le pulmones esseva nodular e dispergite.

Le quarte (miscellanea) gruppo includeva 6 casos de pneumonitis chronic exhibiente un varietate de configurationes. In 2 casos de disseminate pneumonitis focal, le apparentia roentgenographic resimilava forte-mente illo de metastatic morbo nodular. Examines subsequente monstrava un complete resolution del processo. Le biopsias de histo pulmonar esseva un grande adjuta in iste gruppo de casos.

Coal Miners' Pneumoconiosis¹

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IT IS WELL KNOWN that coal mining is a hazardous occupation as a result of accidents, explosions, and roof cave-ins. Less commonly known outside the mining areas and compensation boards is an insidious, but frequently incapacitating, pulmonary condition that has been referred to in American literature as silicosis, anthracosilicosis, anthracosis, miners' asthma and, more recently, coal miners' pneumoconiosis.

In view of the paucity of articles in recent American radiological literature concerning coal miners' pneumoconiosis, the reporting of some of our observations is considered to be in order.

REVIEW OF LITERATURE

As early as 1813 the black lungs of coal miners in Great Britain had been observed at autopsies (16). In 1822 a report was published on coal miners' "asthma" and subsequently there appeared, especially in the British literature, numerous reports concerning the lung diseases of miners, of which an excellent bibliography is provided by Kerr (14). In this country Garland (8), in 1936, presented the x-ray aspects of pneumoconiosis of various types. Other contributions to the subject have been made by Pendergrass and his associates (18-20), who gave special attention to silicosis and anthracosilicosis and their differential diagnosis from the roentgen standpoint; Cole (3) whose extensive discussion covers both the roentgen findings and the pathological changes, including those demonstrable with polarized light; Hinshaw and Garland (13), whose text includes a consideration of pulmonary diseases of occupational origin, with a classification of silicosis. Meschan (17) describes the roentgenographic appearance of the various stages of silicosis, but

mentions only briefly the pulmonary changes in soft coal miners.

Before the 20th century the respiratory difficulties and morbid pulmonary changes observed in coal miners were generally attributed to inhalation of coal dust. Later, silica was labeled as the only harmful dust and silicosis was considered to be the only important occupational dust disease. By 1928, however, British investigators were reporting differences in the radiographic appearances of the lungs of persons exposed to silica and those exposed to coal dust. Since that time the pneumoconiosis found in coal miners and others who work in areas with a high concentration of coal dust in England and Wales has been extensively studied. In particular, the British Medical Research Council has conducted comprehensive studies in the South Wales coal fields. As a result of these investigations three important findings were reported (9): first, that radiological abnormalities in the chest were frequent among coal miners; second, that the largest number of cases were among miners who worked in the dustiest part of the mines, namely, on the coal face; third, that the radiological changes were not limited to the men working underground but were also seen in those working on the surface, where the coal is screened and cleaned, and in those who load the coal into ships.

Classical silicosis has been reported to occur in only a small percentage of the soft-coal miners who have come to autopsy (11). In general it has been found in miners engaged wholly or principally in drilling rock or those exposed to high concentrations of sand dust. In these, the pathological findings are almost identical with those encountered in the silicosis which develops from gold and tin mining or sand

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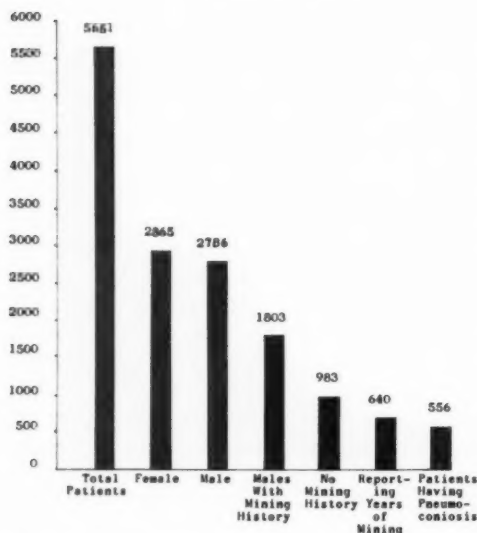


Chart I. Distribution of patients (5,651) having chest roentgenograms.

blasting. The majority of cases of coal workers' pneumoconiosis, however, show pulmonary fibrosis which differs somewhat from that seen in classical silicosis (11).

In simple pneumoconiosis the coal dust is profusely distributed throughout the lungs, producing discrete nodules in which the amount of fibrosis is minimal. These "dust foci" occur around the terminal bronchioles and their accompanying blood vessels. The nodules are black and can be felt in the lung substance as shot-like bodies. The fibrous tissue tends to have a radial disposition instead of the concentric formation of collagen such as occurs in classical silicosis, and the lesions have an irregular border instead of a sharply spherical outline.

Radiographs of thin slices of the involved lung show that the coal nodules are radiopaque, their shadows corresponding to the opacities seen in the radiographs of the lungs of the living patient (11). Around the nodular lesions of simple pneumoconiosis is found a distinctive type of emphysema, referred to as "focal emphysema." This has been extensively studied and described by Heppleston (12). These small emphysematous areas may be

confined to the vicinity of the dust deposits, but sometimes may become confluent to form bullae.

With the coalescence of the nodular lesions, the stage of progressive massive fibrosis develops. When this occurs, the condition is designated as complicated pneumoconiosis. This is a progressive condition regardless of whether or not continued dust exposure occurs. This is in contrast to the reported absence of progression of simple pneumoconiosis if exposure to coal dust is discontinued (2).

Progressive massive fibrosis is characterized by the formation of collagenous nodules from one to several centimeters in diameter, chiefly in the upper lung fields. The factor responsible for this progressive massive fibrosis is thought by many to be superimposed infection, usually tuberculosis. In 1,000 autopsies of miners with massive fibrosis in the lungs, tuberculosis was detectable, either bacteriologically or histologically, in 40 per cent (9).

STUDY MATERIAL

The material for this study consists of the chest films of 5,651 patients (Chart I), primarily from the coal-mining areas of Southeastern Kentucky. Of this group, 2,786, or approximately one-half, were male. A high proportion of this latter number were elderly men, retired from the mining industry or referred from surrounding communities for Old Age Survivors Insurance examinations.

A mining history was obtained in about two-thirds of the men and 640 reported the length of employment. Roentgen changes of pneumoconiosis were found in 556. The distribution of the x-ray findings according to category is shown in Chart II. The average age of the patients in this series was 58.8 years.

Information was available as to the length of time spent in mining in 317 of the patients with pneumoconiosis. Of these, 263 had simple pneumoconiosis and 54 had complicated pneumoconiosis (Table I). The average length of employment in the mines for the group with simple

TABLE I: DISTRIBUTION OF FINDINGS IN 317 PATIENTS REPORTING NUMBER OF YEARS OF SOFT COAL MINING

	Simple Pneumoconiosis	Complicated Pneumoconiosis
Number of patients	263	54
Average age (years)	56.9	65.2
Range (years)	30-88	45-79
Average years of mining	34.2	36.0
Range (years)	10-59	18-50

pneumoconiosis was 34.2 years; for those with complicated pneumoconiosis 36 years.

Of some interest was the average age of these two groups—56.9 years for those with simple pneumoconiosis and 65.2 years for those with complicated pneumoconiosis. The duration of employment ranged from ten years to fifty-nine years. The patient with the longest occupational history (59 years) began working in the mines at the age of nine and continued until he was sixty-nine. One case was found with numerous large nodular shadows in the lungs in association with rheumatoid arthritis of the peripheral joints, as described by Caplan (1).

ROENTGEN CHARACTERISTICS

The chest roentgenogram is the only means by which coal miners' pneumoconiosis can be diagnosed in an asymptomatic person. The diagnosis is based on the nodular opacities in the lungs, together with a history of prolonged exposure to coal dust. The characteristic pulmonary opacities of simple pneumoconiosis are minute (from 0.5 to 3.0 mm. in diameter), more or less circular, well defined nodules. They commonly appear in clumps. This produces a miliary appearance, but fine linear opacities often connect adjacent minute nodules into chains which enclose small translucent areas of emphysema, resulting in a lace-like appearance. Larger, more or less circular opacities, up to 5 mm. in diameter, also occur. In many cases the findings are the same as those ascribed to silicosis, and often in evaluating these cases we feel that the two conditions cannot be differentiated. Short horizontal linear shadows are commonly seen in the basal portions of the lungs ("Kerley

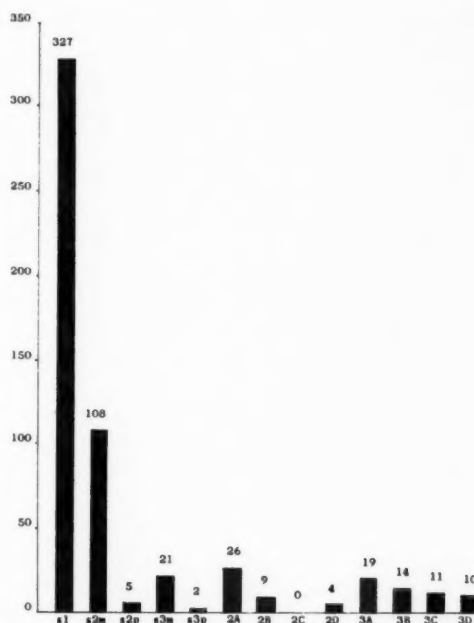


Chart II. Distribution of patients (556) with pneumoconiosis according to category.

lines"), probably due to dust deposition along the intercommunicating lymphatics or interlobular septa.

Accentuated pulmonary markings are frequently associated with the nodular opacities. We feel, however, that the diagnosis of pneumoconiosis can be made only in the presence of the characteristic nodular shadows. In cases with unequal involvement of the two lungs, the right lung practically always showed the more marked changes unless these were masked by emphysema. This is apparently related to the straighter course of the right main stem bronchus. With well developed pectoral muscles, there is decreased penetration of the underlying lung, with resultant accentuation of the markings in this section of the lung field. For this reason, more reliance should be placed on the findings in other portions of the lung fields, especially the infraclavicular region.

In complicated pneumoconiosis, coalescent opacities more than a centimeter in diameter are superimposed on the characteristic nodular lesions of simple pneu-

moconiosis. In the early stages these opacities may be indistinguishable from those of tuberculosis. The lesions have a tendency to progress, with the formation of massive fibrosis. Cavitation is not commonly seen except in the presence of an active complicating tuberculosis. Cavities have been found, however, in the absence of tuberculosis, presumably as a result of ischemic necrosis.

In defining the stages of this disease we have, in general, followed the classification of pneumoconiosis adopted at the International Conference of Pneumoconiosis at Sydney, Australia in 1950 (21). It is closely paralleled by the classification of the Pneumoconiosis Research Unit of South Wales (7). Sets of standard reference films for classifying this condition have been procured from the South Wales Research Unit and have been used extensively in this study.

In practically all cases the chest films diagnosed as showing pneumoconiosis have been read separately by two qualified radiologists, with independent staging of the disease. Differences of opinion were resolved by further discussion or reference to a third radiologist. Coal workers' pneumoconiosis is divided into two major groups: simple pneumoconiosis and complicated pneumoconiosis.

Simple pneumoconiosis is further divided into three categories of increasing abnormality, based chiefly on the profusion

of the opacities (Categories 1, 2, and 3). Categories 2 and 3 are further broken down, according to the predominant size of the opacity, into pinhead, mixed, and nodular types. In our series the larger nodular lesions have always been mixed with the smaller "pinhead" opacities.

Cases showing coalescence or massive shadows (complicated pneumoconiosis) are divided into four categories—A, B, C, and D—based chiefly on the extent of the fibrotic lesions, superimposed on a background of simple 2 or 3 pulmonary changes. In Category A coalescent shadows of more than 1 cm. in diameter are observed. In Category B there are one or more massive shadows extending over less than the equivalent of three anterior rib spaces on either side, while in Category C the massive shadows extend over three or more anterior rib spaces on either side. Category D is reserved for cases showing gross distortion of the intrathoracic structures as a result of fibrosis.

Representative cases illustrating the various categories of the disease are shown in Figures 1-5. The extensive bullous emphysema commonly found as a complication of coal miners' pneumoconiosis is well exemplified by Case VI (Fig. 6).

The following comparison of the classification of pneumoconiosis by the International Pneumoconiosis Conference and the Pneumoconiosis Research Unit shows the similarity of the two systems.

CLASSIFICATION PROPOSED BY THIRD INTERNATIONAL PNEUMOCONIOSIS CONFERENCE (21)

Pneumoconiosis with Discrete Opacities

- 0 Radiographs within normal limits.
1. In these radiographs a small number of opacities may be seen in at least two anterior rib spaces extending over not more than half of the medial two-thirds of the lung fields.
2. In these radiographs opacities extend over more than half of the medial two-thirds of the lung fields but are sparse or absent in the lateral third.

CLASSIFICATION OF PNEUMOCONIOSIS RESEARCH UNIT (7)

Simple Pneumoconiosis

- 0 Films falling within normal limits.
1. A few characteristic opacities 0.5-3 mm. in diameter can be seen, usually in the 2nd, 3rd, or 4th anterior rib spaces, midway between the mediastinum and periphery, more commonly on the right than on the left. Vascular markings are clearly visible. Abnormality must extend over at least 1 sq. cm. in each of two rib spaces.
2. Opacities 0.5-3 mm. in diameter are more numerous and distributed throughout the lung fields, except the peripheral third, where they are sparse or absent. Vascular markings still visible but less clearly than in Category 1.

3. In these radiographs profuse opacities extend over the whole of both lung fields, including the lateral third, although they may be sparse or absent above the clavicles.

In cases where there is an uneven distribution of the opacities in different areas of the lung fields the category is determined by the most advanced abnormality that is present over at least half of a lung field.

- X Radiographs with discrete opacities whose appearance does not accord with any of the preceding categories.

Pneumoconiosis with Coalescent or Massive Shadows

- A. In these films opacities more than 1 cm. in diameter may be seen in one or more areas, commonly coalescing, but not constituting a massive shadow of even density.

- B. In these films one or more massive shadows are present, extending over less than the equivalent of 3 anterior rib spaces on either side.

- C. In these films large massive shadows of uniform density extend over the equivalent of 3 or more anterior rib spaces on either side.

- D. In these radiographs one or more massive shadows are present, associated with gross distortion of the pulmonary anatomy. The massive shadows may of themselves be such as would be classified as A, B, or C in the absence of such distortion.

3. Except for an occasional large vessel in upper or lower zones, vascular markings are obscured by opacities 0.5-5 mm. in diameter profusely distributed throughout lung fields, including outer third of the lung.

4. Opacities 0.5-5 mm. in diameter more profusely distributed throughout the whole of both lung fields.

In cases in which the severity of simple pneumoconiosis varies from one area of the lung field to another, the category is determined by the most advanced disease which is present in at least half of one lung field.

Complicated Pneumoconiosis

- A. Progressive massive fibrosis may first be detected by the presence, in one or more areas of the film, of larger more homogeneous opacities than those characteristic of simple pneumoconiosis. It usually first appears in one or other of the upper zones more commonly on the right side but occasionally it appears in the mid-zone.

At this early stage the shadows are called "ambiguous." The word "ambiguous" is used because there may be ambiguity in the interpretation of some of these shadows, which may resemble tuberculosis infiltration.

- B. In these films, one or more massive shadows may be distinguished. They are more extensive, more homogeneous than the ambiguous shadows, but are still of uneven density. Their outline may be well defined in parts, but in general they are hazy, and are often obscured by surrounding ambiguous shadows.

- C. Massive shadows are now the chief feature of the film. They have an outline that is more clearly defined than in Category B, sometimes by reason of an increase in the surrounding translucency. Their density is more uniform and is usually increased, except in the case of the faint massive shadows, already described.

- D. The massive shadows have the same characteristics as those described under Category C, but distortion of the surrounding structures has taken place. This distortion may affect (a) the mediastinal structures (trachea, hila, and heart); (b) the lung parenchyma, giving rise to large translucent areas; (c) the diaphragm, giving rise to peaking, flattening, or haziness of the outline. A film is placed in this category when at least two of these types of distortion are present.

Differential diagnosis includes other types of pneumoconiosis, sarcoidosis, miliary tuberculosis, lymphangitic carcinomatosis,

hemosiderosis, fungous diseases, idiopathic pulmonary fibrosis, eosinophilic granuloma, and pulmonary fibrosis seen in some "colla-

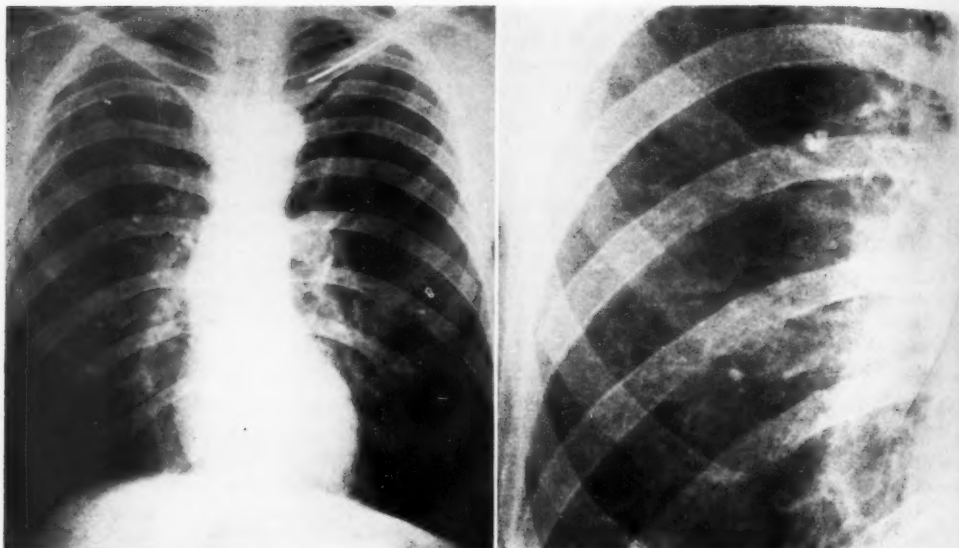


Fig. 1. Case I: Pneumoconiosis, simple, category 1. Patient twenty-five years in mines. Minimal nodular and linear fibrosis with focal emphysema. Enlargement of right mid-lung field on the right.

gen" diseases. Differentiation of coal workers' pneumoconiosis from silicosis may be impossible. In general, it can be stated that the pulmonary lesions of the latter develop more rapidly. The "egg-shell calcification" of hilar nodes occasionally seen with silicosis has rarely been observed in simple coal miners' pneumoconiosis.

The markedly enlarged hilar nodes of sarcoidosis are seldom present in coal miners' pneumoconiosis. The parenchymal lesions of the latter tend to be progressive instead of receding, as in the case of the former. Miliary tuberculosis and fungous diseases may be identified on cultures of sputum. Pulmonary hemosiderosis is practically always accompanied by enlargement and characteristic configuration of the cardiac shadow. Carcinomatosis can usually be established by a short period of observation. In some cases the differential diagnosis cannot be made short of a lung biopsy or autopsy.

CASE REPORTS

The following cases illustrate various stages of pneumoconiosis seen in soft coal miners:

CASE I (Fig. 1). *Pneumoconiosis, Simple, Category 1*: A 47-year-old white male was first seen on May 16, 1957, complaining of vertigo which was attributed to labyrinthitis. He had worked in the mines for twenty-five years but had no symptoms referable to the chest except for a nonproductive cough of several months duration and mild dyspnea on exertion.

Physical examination revealed no significant abnormality. Chest roentgenogram showed a minimal degree of generalized pulmonary fibrosis with mild basilar emphysema which was compatible with occupational pneumoconiosis. One year before the patient was seen at this hospital the left clavicle had been broken and was repaired by open reduction and mechanical fixation.

CASE II (Fig. 2). *Pneumoconiosis, Simple, Category 2, Mixed*: A 46-year-old white male had worked in the mines for twenty years—six to eight years on the cutting machine and thirteen years on a Joy loader. He first became symptomatic one year before admission, with shortness of breath on exertion. This, however, had not been sufficient to interfere with his performing his job. He seldom had attacks of "wheezing." There was no cough or pain in the chest. Climbing two flights of stairs caused mild dyspnea.

Physical examination revealed no significant abnormality. Chest roentgenogram showed linear and nodular areas of fibrosis throughout both lung fields consistent with simple occupational pneumoconiosis. A calcified nodule in the left upper lobe with associated hilar nodes was attributed to a healed granulomatous inflammatory process.

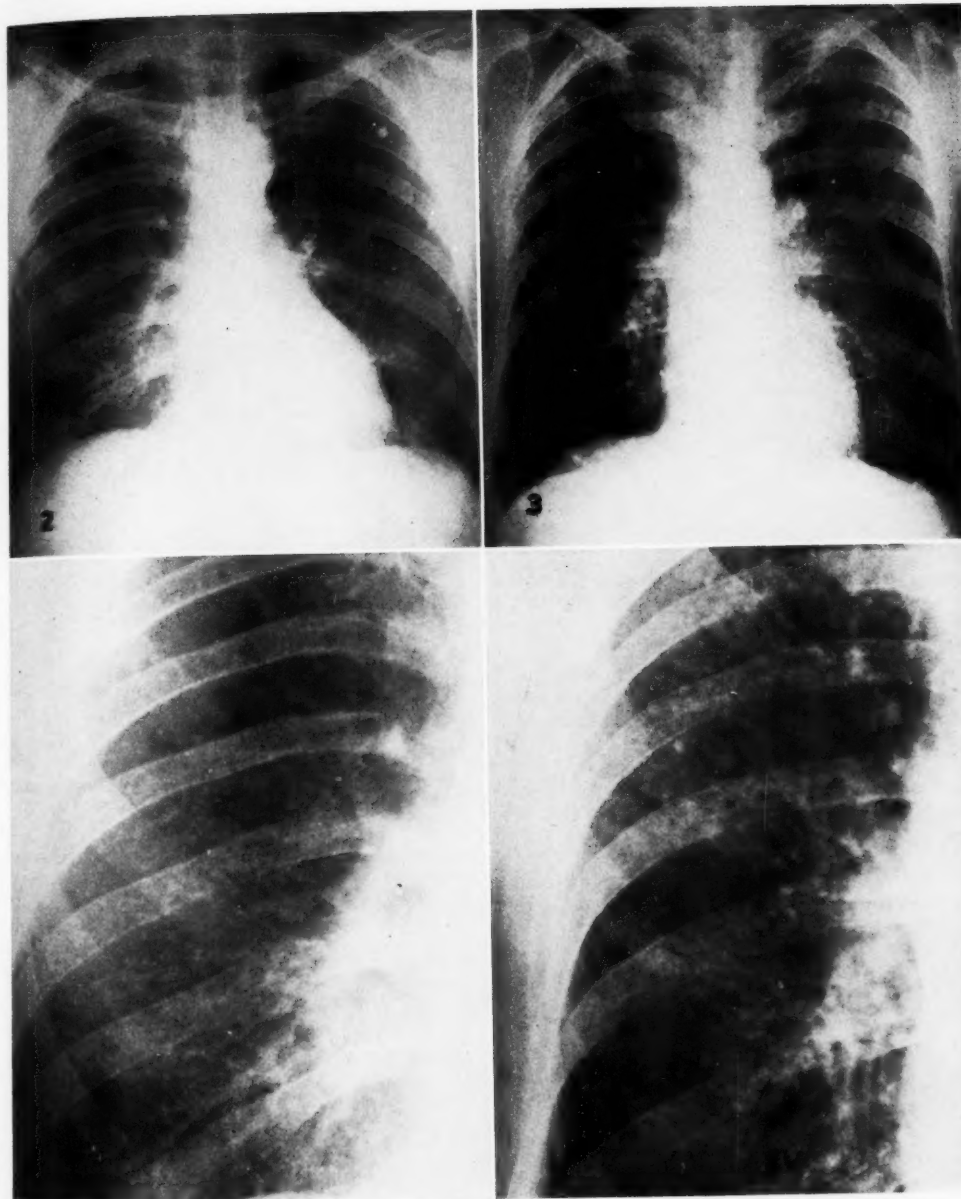


Fig. 2. Case II: Pneumoconiosis, simple, category 2, mixed. Patient twenty years in mines. Moderate, generalized, nodular and linear fibrosis. Maximum breathing capacity 52.5 per cent of normal. Below: Right mid-lung field enlarged.

Fig. 3. Case III: Pneumoconiosis, simple, category 3, mixed. Patient eighteen years in mines. Extensive nodular fibrosis and moderate focal emphysema. Below: Right mid-lung field enlarged.

Pulmonary function studies revealed a maximum breathing capacity 52.5 per cent of normal, residual air 26.05 per cent of total volume, vital capacity 100 per cent of normal, and velocity of air flow 2,600 c.c. per second. *Conclusion:* Pulmonary insufficiency,

moderate; unable to do hard manual labor but able to do many jobs out of the mines.

CASE III (Fig. 3). *Pneumoconiosis, Simple, Category 3, Mixed:* A 50-year-old white miner entered



Fig. 4. Case IV: Pneumoconiosis, complicated, category 3B. Marked generalized fibrosis of both lungs, with coalescence of the nodular lesions in the upper lobes.

the hospital on Nov. 19, 1956, with an acute upper respiratory infection. He had worked in the mines for eighteen years, but had had no symptoms referable to the chest until two years prior to admission, when he noticed minimal exertional dyspnea. This increased in degree and was accompanied by repeated episodes of upper respiratory infection. A few months before admission, the patient was no longer able to work due to dyspnea and cough. Over a two-year period there had been occasional episodes of minimal hemoptysis. No other symptoms referable to the chest had been experienced.

Physical examination revealed a few râles in the right lung field and a moderate degree of dyspnea. With symptomatic treatment, the patient improved and was discharged from the hospital but was seen on several occasions after that time with repeated upper respiratory infections. The laboratory findings were within normal limits. No acid-fast bacilli were found on smears or culture of the sputum. Serologic tests for syphilis were negative. Roentgenograms of the chest revealed extensive nodular fibrotic lesions throughout both lung fields. Over a period of fifteen months the roentgenographic appearance of the chest has shown no significant change. The patient is able to carry out work involving only limited physical exertion.

CASE IV (Fig. 4). *Pneumoconiosis, Complicated, 3B:* A 57-year-old white male had worked in the mines for forty-three years, thirty years of this being on the cutting machine. A diagnosis of "silicosis" was made in 1954, but at that time the patient had

only an occasional cough, which was nonproductive, and mild shortness of breath on exertion. He had continued to work until February 1956, when his cough became more severe and he expectorated a considerable amount of black mucoid sputum for a few days. He also experienced some pain in the left upper chest at that time. He was hospitalized elsewhere and a diagnosis of "silicosis and moderate



Fig. 5. Case V: Pneumoconiosis, complicated, category 3D. Patient forty-six years in mines. Severe fibrosis of upper lung fields with distortion of intrathoracic structures and compensatory emphysema, with minimal fibrosis in the lower lung fields. There is bilateral cavitation despite a negative tuberculin test and repeatedly negative sputa examinations for acid-fast bacilli.

pulmonary fibrosis" was made. Repeated bacteriologic studies at that time failed to reveal acid-fast bacilli. The patient improved with symptomatic treatment but was unable to return to work. His condition gradually deteriorated and he expired on Oct. 15, 1956. Autopsy revealed massive complicated pneumoconiosis with cavitation (though no evidence of tuberculosis was found), with secondary cor pulmonale and acute myocardial failure. Lung analysis showed 1.077 gm. of silica expressed as SiO_2 per 100 grams of anhydrous tissue. This is approximately five times the normal content for an individual of this patient's age.

CASE V (Fig. 5). *Pneumoconiosis, Complicated, 3D:* A 76-year-old white male was first hospitalized on April 16, 1956, complaining of marked shortness of breath, the onset of which dated back to March 1955, following an upper respiratory infection. Since that time he had experienced increasing exertional dyspnea and "asthma." There was no

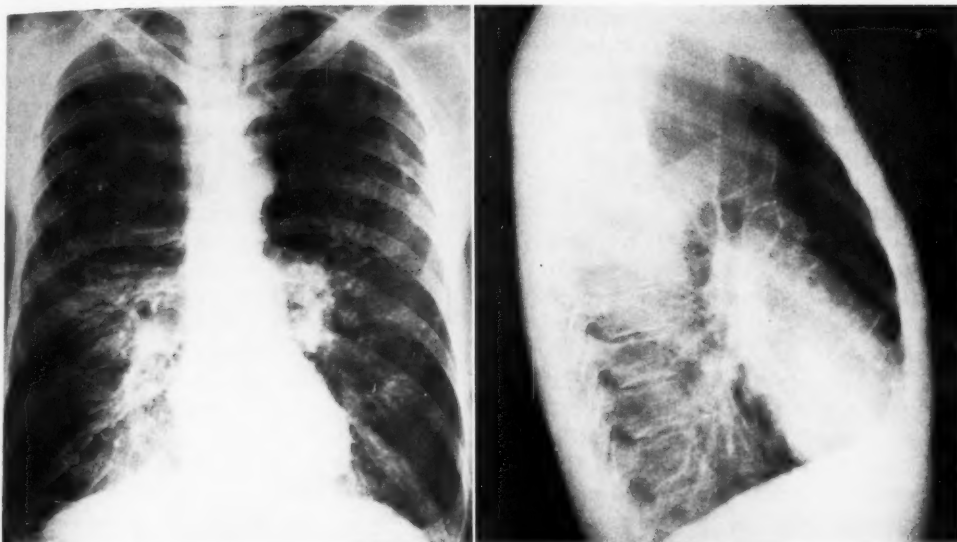


Fig. 6. Case VI: Pneumoconiosis, simple, category 2, mixed, with bullous emphysema. Patient twelve years in mines starting twenty years ago. Severe bullous emphysema in upper lung fields and moderate fibrosis with focal emphysema in lower lung fields.

orthopnea or edema, but he had a persistent cough with production of a small amount of "yellow phlegm." He gave a history of working in the coal mines for forty-six years, mainly as a coal loader.

Physical examination revealed an emphysematous, hyperresonant chest and severe exertional dyspnea, but no other significant findings.

With symptomatic treatment the patient improved sufficiently to leave the hospital. Since that time he has been readmitted ten times for short periods of hospitalization, primarily because of his lung disease. During these various admissions repeated sputum cultures have been negative for acid-fast bacilli. He also had a negative tuberculin test. Other laboratory tests were within normal limits. A laminagram early in the course of his disease showed extensive fibrosis in the upper lung fields, with distortion of the intrathoracic structures and compensatory emphysema and mild fibrosis of the lower lung fields. There was no cavitation demonstrable initially, but in January 1957 small cavities developed, accompanied by the production of large amounts of black sputum. Again, sputum cultures showed no acid-fast bacilli. The patient has had auricular fibrillation and mild congestive failure on several occasions. A diagnosis has also been made of cor pulmonale secondary to the pulmonary fibrosis. A satisfactory response has been obtained to symptomatic treatment, which has included smooth muscle relaxants and intravenous steroids.

CASE VI (Fig. 6). *Pneumoconiosis, Simple, 2, Mixed, with Bullous Emphysema*: A 42-year-old white male was admitted to the hospital on April

24, 1957, complaining of "chest trouble" of four years duration. He had started working in the mines in 1937 and continued for approximately twelve years. He had no significant lung complaints until 1952, when he began to suffer from shortness of breath on exertion, a productive cough, and a feeling of tightness in his chest. These had gradually increased in severity and he gradually lost weight. Other than this his general health had been good.

Physical examination revealed an emphysematous chest with occasional moist râles at both bases. A chest film revealed extensive bullous emphysema involving the right upper lobe. The remaining lung fields showed extensive fibrosis and focal emphysema. The maximum breathing capacity was 36 per cent of normal, vital capacity 62.5 per cent of normal, and residual air 59.4 per cent of total volume.

The patient improved somewhat on symptomatic treatment, but there was no change in the appearance of the lung fields. Subsequently, surgical resection of the apical and posterior segments of the right upper lobe was done, with considerable benefit. The excised portions of the lung showed bullous emphysema, fibrosis, and anthracosis.

DISCUSSION

The pathogenesis of the fibrosis in coal workers' pneumoconiosis has not been unequivocally determined. Some rock drilling and sanding of the tracks occurs in practically all mines and is a source of some silica dust. A very small concentra-

tion of silica is found in bituminous coal itself, but the concentration is below that usually considered to be dangerous in mine dust. However, the development of severe pneumoconiosis in coal trimmers, an occupation involving the loading of coal aboard ships, as reported by Gough (10), would indicate that the coal dust is the primary etiologic factor. Frequently, we are unable to differentiate between "silicosis" and "coal miners' pneumoconiosis" and make no attempt to do so in reporting these cases.

The slowness with which the pathological changes usually develop in the group of patients studied for this report is exemplified by the fact that the majority of patients who have unequivocal x-ray findings of coal workers' pneumoconiosis give a history of having worked fifteen or more years in the mines. This is in contrast to the relatively short period required for evidence of silicosis to appear in individuals exposed to high concentrations of silica dust. The length of time required for roentgenographic evidence of coal workers' pneumoconiosis to develop will vary greatly with the concentration of dust. Fletcher (6) stated that he saw diagnostic lung changes in one man after only five years exposure in a dusty mine.

In the United States "silicosis" has been a compensable disease, in accordance with the Workmen's Compensation Laws, for a number of years. This has resulted in a considerable amount of disagreement and litigation in deciding whether the individual miner with fibrotic changes in the lungs should be classified as having "silicosis," or some other condition, which is non-compensable. Recent legislation in some states has broadened the scope of compensable disability to include practically all pneumoconiosis incurred as a result of occupation. This makes the differentiation between "silicosis" and "coal workers' pneumoconiosis" somewhat academic but places a very considerable responsibility on the radiologist in establishing the diagnosis of occupational pneumoconiosis.

Hinshaw and Garland reproduce a

complete comparison of the two classifications listed, including explanatory notes. They also present a simplified classification of pneumoconiosis (silicosis) based on the combined recommendations of the International Labor Organization and the British Pneumoconiosis Research Unit.

The diagram by Fletcher (4), in Figure 7, has been of considerable assistance in classification and serves as a quick reference for coding purposes. We do not, however, report the number of rib interspaces involved, other than the degree of involvement indicated by the category listed. Thus, instead of reporting "3A 2/1" we would report "Category 3A."

For accurate diagnosis it is essential that chest films of the best possible quality be obtained. The length of exposure should not exceed one-tenth of a second. The kilovoltage used in this series has been in the range of 55 to 70 kv. Penetration should be adequate to visualize the outline of the spine through the heart, without the vertebral interspaces being visible. Par-speed screens have been used, though a finer grain screen would give better detail and is used for survey work reported by the British Pneumoconiosis Research Unit. The fibrotic nodules are more evident on films made with a relatively low kilovoltage, but this also increases the possibility of "overreading," especially in the obese patient.

Cases were commonly found in which lung changes were noted which were considered to be the result of dust accumulation, but were insufficient for a definite diagnosis of Stage 1 pneumoconiosis. These were reported as "accentuated markings" only.

SYMPTOMATOLOGY

In the early stages coal miners' pneumoconiosis is asymptomatic. At this stage it is revealed only by a survey chest film or roentgenogram of the chest incidental to examination for some other illness. In the more advanced stages the condition becomes symptomatic. Breathlessness on exertion in a patient with a








Normal Range			Code
Abnormality simulating Pneumoconiosis but not caused by Dust			x/-
PNEUMOCONIOSIS	Category	Appearance	
Simple (Pneumoconiosis with discrete opacities U.S.A. 1950)	1		1 1--1
	2 $\left\{ \begin{array}{l} \text{Pinhead } p \\ \text{Mixed } m \\ \text{Nodular } n \end{array} \right.$		2p 1--1 2m 1--1 2n 1--1
	3 $\left\{ \begin{array}{l} p \\ m \\ n \end{array} \right.$		3p 1--1 3m 1--1 3n 1--1
Complicated (Pneumoconiosis with coalescent or massive shadows U.S.A. 1950)	A		3A 2/1
	B		3B 3/3
	C		7C 4/5
	D		7D 5/4

Fig. 7. International Radiological Classification of Pneumoconiosis (Reproduced from Fletcher, C. M.: Arch. Indust. Health 11: 17, 1955). In this classification the category of complicated pneumoconiosis is indicated by a capital letter, superimposed on a background of simple changes indicated by a number. The numbers separated by an oblique line represent the anterior rib spaces on the right and left sides respectively, on which the P.M.F. extends.

history of having worked in coal mines for several years should suggest the possibility of pneumoconiosis. Severe breathlessness and distressing cough usually do not occur early in the course of the disease. The production of coal-stained sputum is common among miners and generally considered to be harmless, but copious production of inky-black sputum is suggestive of complicated pneumoconiosis with tissue necrosis. The clinical history and physical examination commonly contribute little to the diagnosis, especially in the early stages. They are important, how-

ever, in differentiating pulmonary and cardiac conditions complicating or simulating pneumoconiosis. Asthenia, loss of weight, tightness of the chest, and complaints referable to the upper gastrointestinal tract are common symptoms of a patient who is disabled by his pneumoconiosis. Cor pulmonale is commonly present in the advanced stages of the disease.

DISABILITY

Disability is usually manifested by dyspnea on exertion. Exertional dyspnea

may, however, be on the basis of other conditions such as cardiac disease, emphysema which is unrelated to pneumoconiosis, and numerous other causes. This symptom may also be aggravated by psychogenic factors. In cases of simple pneumoconiosis, the degree of disability may be difficult to evaluate and commonly shows a poor correlation with the x-ray findings. It can be assessed most reliably by an experienced clinician using pulmonary physiology tests in conjunction with study of the chest roentgenogram. Disability evaluation has become particularly important, since compensation is primarily contingent upon its degree. Determination of the maximum breathing capacity and timed vital capacity seem to be the most accurate tests in evaluating disability.

PREVALENCE AND PREVENTION

No attempt has yet been made in this community to determine the incidence of pneumoconiosis among the mining population, and the prevalence of coal miners' pneumoconiosis in the United States remains unknown. Martin (15) estimates that there may be as many as 25,000 to 58,000 miners disabled by "pneumoconiosis of soft coal miners" in this country. This is based on an assumption of a soft-coal-mining population of 450,000 in the United States and a comparison with a survey made in 1947 in Wales, in which the disabled population was 5.6 per cent of the maximum number employed in the mines and 12.9 per cent of the working population. Fletcher (5) reports that nearly 40,000 cases of pneumoconiosis have been certified among coal miners in Great Britain during the past twenty years.

In view of the irreversible changes associated with this disease and the disability that it causes in its advanced stages, prevention becomes of great importance. It is a preventable disease, but the wearing of masks that are available at the present time is apparently not feasible, and the suppression of dust is a costly process. The latter is primarily an

engineering problem. Recent legislation making pneumoconiosis a compensable disease may stimulate the use of preventive measures which are needed.

SUMMARY

A series of 556 cases of coal miners' pneumoconiosis has been studied in a period of twenty-one months in a relatively small hospital in a mining area of South-eastern Kentucky. This is a prevalent and often disabling condition among miners working in the bituminous coal mines.

The roentgenographic manifestations and clinical features have been briefly discussed. The pulmonary changes become evident slowly. The vast majority of these patients have worked twenty or more years in the mines.

There is little correlation between the extent of the lesions seen on the roentgenogram in simple pneumoconiosis and the degree of disability. Complicated pneumoconiosis is commonly a cause of marked disability.

There is a need for wider recognition of this condition. Further research into its causes, with particular emphasis on its prevention, should be carried out.

NOTE: Appreciation is expressed to David McL. Greeley, M.D., for aid in preparation of this report, and to William H. Anderson, M.D., for the clinical information included.

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SUMMARIO IN INTERLINGUA

Pneumoconiosis Del Minatores De Carbon

Esseva studiate un serie de 556 casos de pneumoconiosis del minatores de carbon, vidite in le curso de vinti-un menses a un relativamente micre hospital in Kentucky.

Pneumoconiosis es un prevalente e frequentemente invalidante condition inter minatores de carbon grasse. Illo es incontrate principalmente in minatores qui ha travaliato multe annos—vinti o plus—in le minas. In pneumoconiosis simple, le pulvere de carbon es distribuite diffusemente in omne partes del pulmones, resultante in le formation de nodulos discrete in que le quantitate de fibrosis es minimal. Quando le lesiones nodular se coalesce, le stadio de fibrosis progressive es attingite, e le condition es classificate como pneumoconiosis complicate.

Le roentgenogramma thoracic es le sol medio existente pro diagnosticar pneumo-

coniosis de minatores de carbon in un subjecto asymptomatic. Le diagnose se basa super le presentia de opacitates nodular in le pulmones, insimul con un historia de longe periodos de exposition a pulvere de carbon. In casos de pneumoconiosis complicate, le umbras coalescente es superimponite super le characteristic lesiones nodular del varietate simple.

Le alterationes pulmonar deveni lentamente evidente. In pneumoconiosis simple lor extension es pouco correlationate con le grado del invaliditate. Pneumoconiosis es communmente le causa de marcate grados de invaliditate.

In vista del irreversibilitate del alterationes associate con le morbo e in vista del invaliditate que illo causa in su stadios avantiato, su prevention es un desiderato de grande importantia.

Plain Film Diagnosis of Fulminating Ulcerative Colitis¹

FLEMING McCONNELL, M.D., JOSEPH HANELIN, M.D.,² and LAURENCE L. ROBBINS, M.D.

FULMINATING ulcerative colitis is a grave form of idiopathic ulcerative colitis, and its management is invariably an extremely difficult problem, demanding skillful application of medical and surgical technics. We have recently examined 26 cases of colitis of this type in which a striking and frequently specific appearance of the colon was observed on plain radiographs of the abdomen. The value of the plain film in this condition, apart from its demonstration of colonic distention, has received virtually no attention in the literature, despite the other gross alterations which may be visible in the gas-filled bowel. Because the severity of the illness and the likelihood of perforation often preclude any more elaborate radiological procedures, it seems pertinent to discuss these radiographic changes and relate them to the clinical and pathological aspects of the disease.

Large series at this hospital and elsewhere have shown that about one in twenty cases of ulcerative colitis will be of the fulminating variety, either initially or as an exacerbation of pre-existing chronic colonic disease. In our group of 26 cases, more than one-third appeared with the fulminating episode as the initial manifestation.

The term fulminating is used by Bockus (1) to describe those cases of acute ulcerative colitis in which "the onset is relatively abrupt and the severity of the attack may reach its peak in two or three weeks. The attack may continue for weeks or months and terminate fatally, pass into a chronic stage, or into a remission." The clinical picture is striking, with cardinal symptoms of abdominal pain, bloody diarrhea, vomiting, high fever, and prostration, which may develop

within a few weeks or occasionally in a few days. Abdominal distention with localized or diffuse tenderness is present, and peristalsis is diminished. Proctoscopy and sigmoidoscopy almost invariably reveal an active ulcerating disease process. The diagnosis, therefore, is usually established on the basis of clinical findings. However, the presence of abdominal pain and distention usually prompts a plain film study and this affords the radiologist an opportunity to make the definitive diagnosis. In any case, it enables him to give valuable confirmatory information. The plain film may also uncover possible complications and additional disease processes, and occasionally, when diarrhea has not been a feature of the illness, clinically unsuspected colitis may be recognized.

PATHOLOGY

Following total colectomy in cases of fulminating colitis, a striking feature frequently found on examination of surgical specimens is irregular thickening of the bowel wall throughout its entire length, or width, or both. The wall is friable and the thickening is due to inflammatory infiltration, primarily of the mucosa, often also of the muscular layer, and even of the serosa. Extensive deep ulcerations separate islands of inflamed mucosa, producing a nodular or so-called pseudopolypoid appearance (Fig. 1). Ulceration usually extends only to the muscular layer but may penetrate almost to the serosa. Occasionally the wall of the distended bowel may be strikingly thinned, and in places the bowel may be actually translucent, or may be found, postmortem, to be dissolved partially over large areas (4, 5). In these cases only occasional nodules of hypertrophic inflamed mucosa may pro-

¹ From the Department of Radiology, Massachusetts General Hospital, Boston, Mass. Presented as a Scientific Exhibit at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17-22, 1957.

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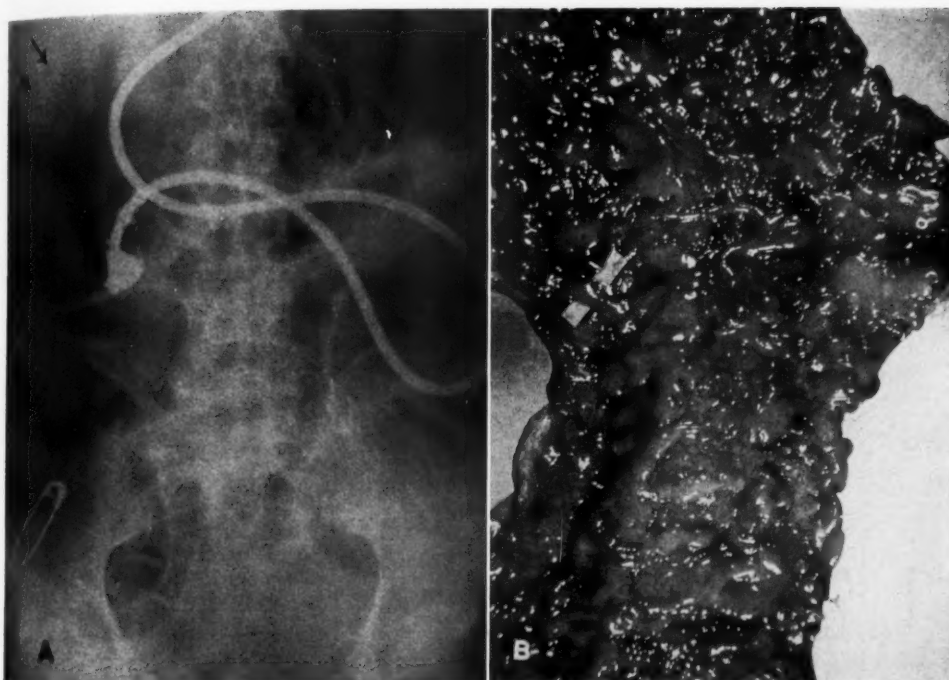


Fig. 1. P. M. A. Supine abdominal film two days before death, showing small- and large-bowel distention. Changes not pathognomonic, although minor mucosal alterations visible in transverse portion. Presence of ascites suggested by diffuse increase of density over pelvis.

B. Gross specimen of colon showing inflammatory nodules and adjoining ulcers.

trude into the lumen. The colon is distended and haustrations tend to be diminished or absent.³ Almost invariably the entire colon is affected, and at times the last few centimeters of the ileum. The extent of these abnormalities may suggest that the disease is of considerable duration, but we have seen the full-blown radiological and pathological appearance develop in a previously normal appearing bowel within less than two weeks. In one case it was reported that these changes occurred within three days of the onset of symptoms.

The most dangerous complication of this disease process is perforation of the colon (Fig. 2), with occasionally a local leak limited by adhesions, but much



Fig. 2. F. P. Supine abdominal film five days before acute perforation. Distended colon; nodular defects resulting from localized mucosal thickening visible in transverse portion; streaks of free air in left upper quadrant.

³ Haustrations are the saccular dilatations of the bowel caused by the *Taenia coli* being shorter than the circular muscular coat. The semilunar or crescentic folds separating the haustra represent double thicknesses of the bowel wall which project into the lumen as transverse indentations.

SUMMARY OF CASES OF FULMINATING COLITIS*

Case	Age and Sex	Onset of Symptoms	Onset of Acute Symptoms	Plain Film of Abdomen			Treatment		Outcome and General Notes	
				Dilated Colon	Changes Visible in Wall of Colon	Dilated Small Bowel	Medical	Ileostomy Colectomy	Extent of Colon Involved	
W. A.	27 M	2 wk.	2 wk.	X	0	X		X	Entire	Died postoperatively†
J. B.	26 M	10 mo.	1 wk.	X	0	X	X		"	Improved after 1 week.
Ep. 1	27 M	22 mo.	10 days	X	X	X	X		"	Improved after 1 month.
Ep. 2										
P. C.	56 M	7 mo.	2 wk.	X	0	X	X		"	Perforated colon; died.
M. C.	62 F	2 yr.	3 wk.	X	0	0	X		"	Improved after 2 weeks.
A. D.	48 M	22 yr.	2 mo.	X	0	X		X	"	Satisfactory.
D. D.	38 F	6 mo.	2 wk.	X	X	X		X	"	Satisfactory.
R. F.	42 M	20 yr.	2 wk.	X	0	X		X X	"	No response to ileostomy. Satisfactory response to colectomy.
P. G.	18 F	3½ mo.	1 wk.	X	X	X	X		Cecum not involved	Improved after 1 month.
A. K.	12 days M	2 days	2 days	X	0	X	X		Entire	Died 15 days later. No perforation.
G. L.	22 F	4 yr.	11 days	X	0	X	X		"	Improved after 1 week.
A. M.	51 F	20 yr.	2 wk.	X	X	X		X X	"	No response to ileostomy. Satisfactory response to colectomy.
P. M.	61 M		In hosp.	X	0	X	X		"	Died after 2 weeks. No perforation.
W. M.	40 M	3½ wk.	2½ wk.	X	X	X		X	"	Satisfactory.
F. M.	48 M	2 mo.	3 wk.	X	X	X	X		"	Died after 1 week.
R. M.	23 M	4 yr.	1 wk.	X	X	X		X	"	Satisfactory.
S. M.	39 F	1½ yr.	3 wk.	X	X	0	X		"	Improved after 1 week.
R. M.	48 M	5 yr.	2 wk.	X	X	X		X	"	Satisfactory.
R. P.	3 M	3 wk.	3 wk.	X	0	X	X		Descending colon not involved	Died after 1 week. Perforated.
F. P.	27 F	7 wk.	2 days	X	X	0		X	Entire	Perforated. Rescued by colectomy.
M. R.	38 F	3 wk.	3 wk.	X	X	0		X	"	Satisfactory.
D. S.	26 M	7 wk.	7 wk.	X	X	0	X		"	Improved after 2 weeks.

SUMMARY OF CASES OF FULMINATING COLITIS*—cont.

Case	Age and Sex	Onset of Symptoms	Onset of Acute Symptoms	Plain Film of Abdomen			Treatment		Outcome and General Notes	
				Dilated Colon	Changes Visible in Wall of Colon	Dilated Small Bowel	Medical	Ileostomy Colectomy	Extent of Colon Involved	
J. S.	34 M	6 wk.	6 wk.	X	X X	X		X	Entire	Perforated. Rescued by colectomy.
I. S.	46 F	8 mo.	1 wk.	X	X 0		X		"	Improved after 3 weeks.
H. S.	51 M	28 yr.	4 wk.	X	X X	X	X		"	Improved after 5 days.
D. S.	66 M	4 yr.	1 mo.	X	X X	X		X	"	Satisfactory.
B. Z.	28 F	1½ yr.	2 wk.	X	0 X	X	X		"	Satisfactory.

* "Age" is at time of admission to hospital. "Onset of symptoms" is period prior to admission to hospital.

† Case courtesy of Newton-Wellesley Hospital.

more frequently with general peritoneal soiling.

ROENTGENOGRAPHIC APPEARANCE

The morbid anatomic changes of distention and shortening of the colon, irregular thickening of the bowel wall, nodular mucosal elevation, and intervening thinning or ulceration, may produce on the plain abdominal film an appearance which is diagnostic of fulminating ulcerative colitis. In supine films the colon is seen to contain an excess of gas, with the transverse portion (Fig. 3) usually showing most marked distention. Thickened inflamed mucosa forms irregular nodules (Fig. 4, A and B) which protrude into the air-filled lumen and cause the outline of the gas shadow to be irregular, nodular, or scalloped. The nodular outline may be seen not only along the margin of the bowel but may be a striking feature in the thickening of the semilunar folds when these have not been effaced by pre-existing chronic colitis. When seen *en face*, the bowel wall has a mottled or cobblestone (Fig. 4, C) appearance, due apparently to contrast between inflamed thickened mucosal

islands and the adjacent thinned and ulcerated regions. The extent and severity of these changes may vary from one portion of the bowel to another and, while this nodular appearance is usually best seen against the distended lumen of the transverse colon, not infrequently it can be outlined by air in other portions of the colon, particularly the sigmoid. Retained fecal matter, more commonly in the cecum and ascending colon, may obscure changes in the bowel wall, but the left half of the colon usually contains only gas, thus permitting more positive recognition of inflammatory changes in the wall. As in chronic colitis, haustral saccululation may be entirely absent even in these markedly distended bowels.

Thickening of the wall of the colon (Fig. 5) may also be demonstrated on plain films, as separation of the faint radiolucent line of pericolic fat from the gas-filled lumen. Often this is best seen along the lateral abdominal wall, but it may be visible along the transverse colon. Despite the marked gaseous enlargement of the bowel, it occasionally appears to be actually shorter than normal without apparent redundancy in the transverse

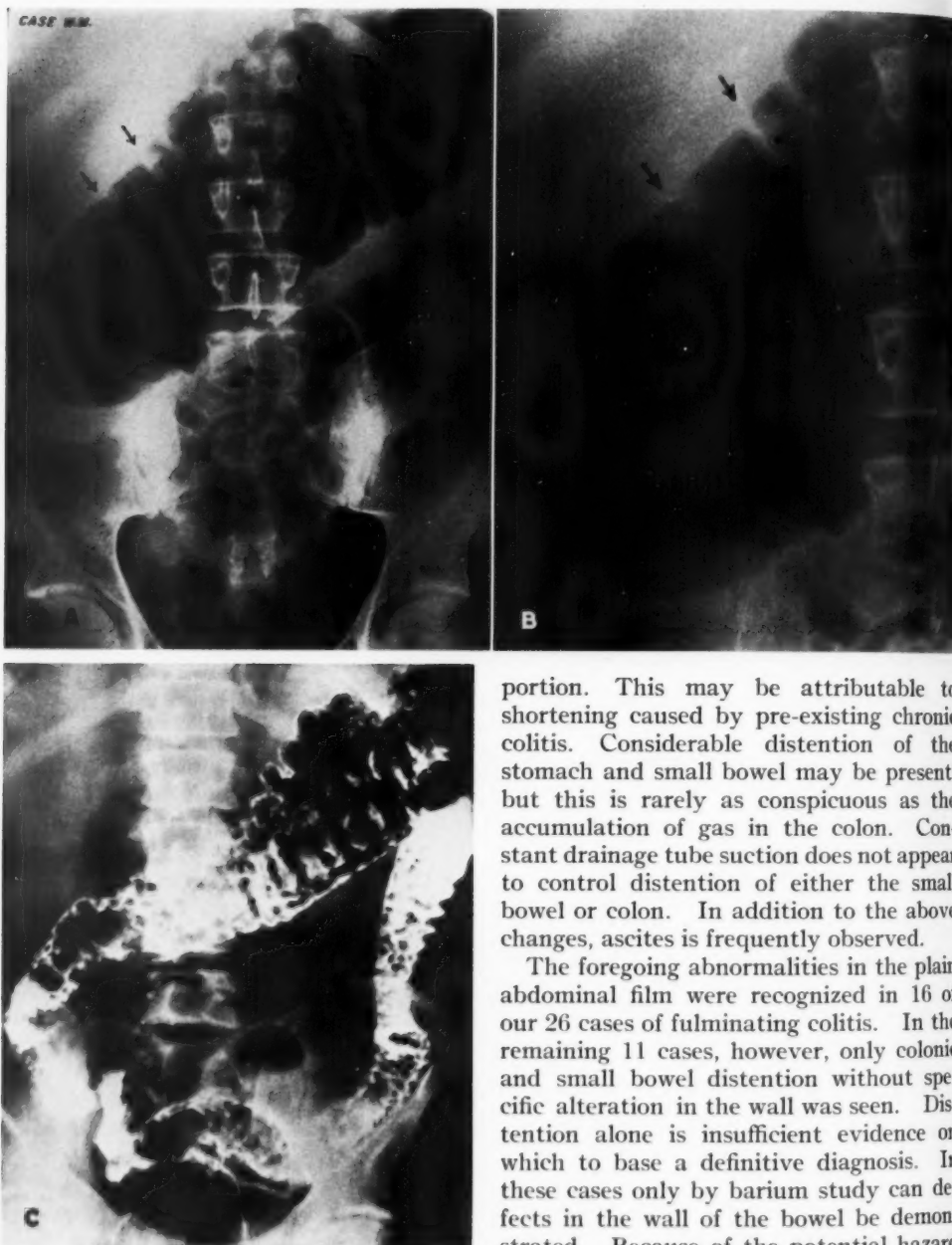


Fig. 3. W. M. A. Supine abdominal film. Greatly distended transverse colon; visible polypoid mucosal changes in transverse portion (upper arrows); thickened semilunar folds and bowel wall.

B. Detail view of proximal portion of transverse colon (from Fig. 3, A), showing polypoid mucosal thickening.

C. Barium enema study two days after plain film, showing polypoid thickening and ulceration.

portion. This may be attributable to shortening caused by pre-existing chronic colitis. Considerable distention of the stomach and small bowel may be present, but this is rarely as conspicuous as the accumulation of gas in the colon. Constant drainage tube suction does not appear to control distention of either the small bowel or colon. In addition to the above changes, ascites is frequently observed.

The foregoing abnormalities in the plain abdominal film were recognized in 16 of our 26 cases of fulminating colitis. In the remaining 11 cases, however, only colonic and small bowel distention without specific alteration in the wall was seen. Distention alone is insufficient evidence on which to base a definitive diagnosis. In these cases only by barium study can defects in the wall of the bowel be demonstrated. Because of the potential hazard of perforation, the radiologist is reluctant to subject these patients to the trauma of an enema examination, but repeated abdominal films often will bring to light (or make visible) hitherto unseen changes in the wall itself. Very rarely does a

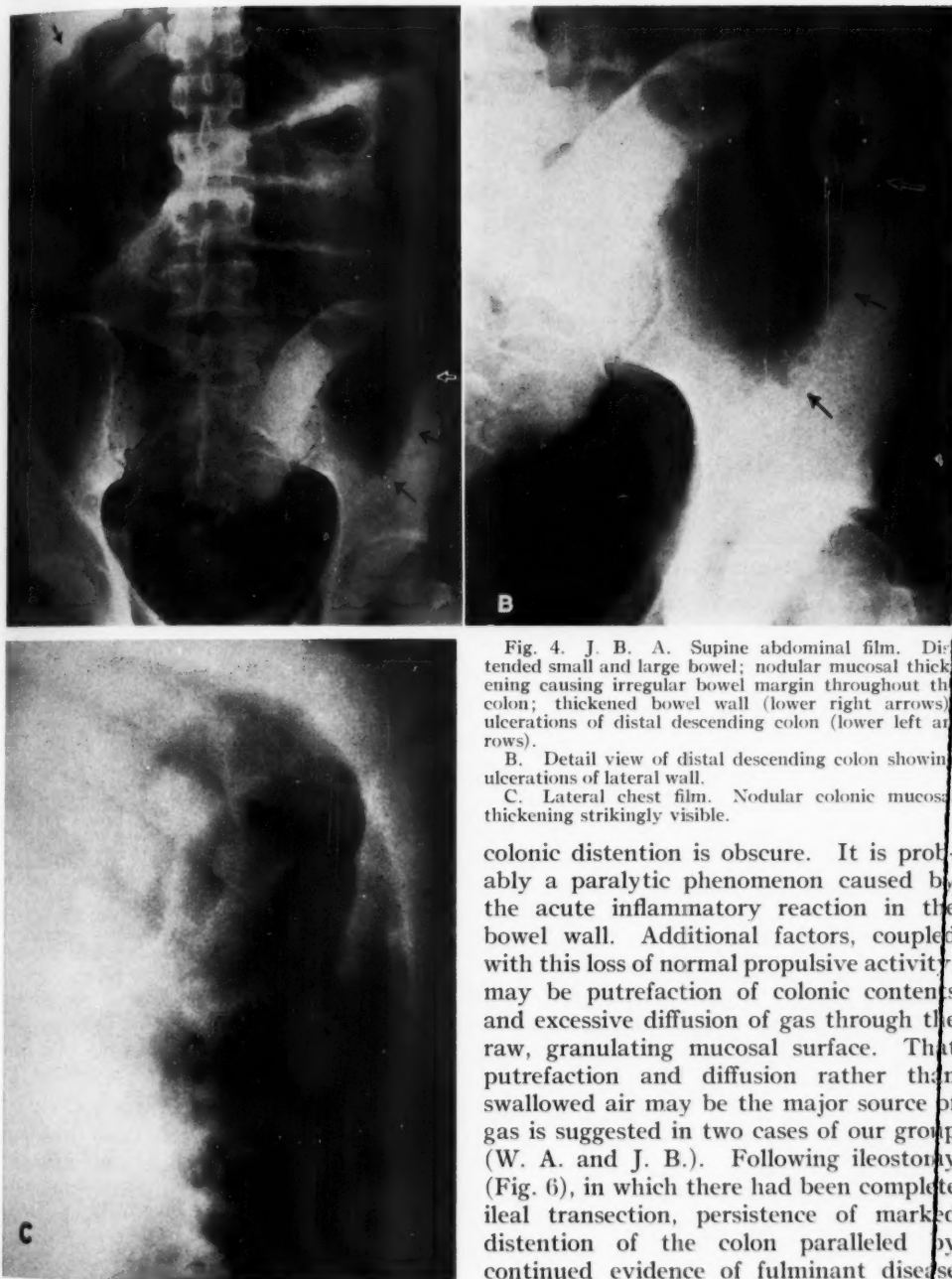


Fig. 4. J. B. A. Supine abdominal film. Distended small and large bowel; nodular mucosal thickening causing irregular bowel margin throughout the colon; thickened bowel wall (lower right arrows); ulcerations of distal descending colon (lower left arrows).

B. Detail view of distal descending colon showing ulcerations of lateral wall.

C. Lateral chest film. Nodular colonic mucosal thickening strikingly visible.

colonic distention is obscure. It is probably a paralytic phenomenon caused by the acute inflammatory reaction in the bowel wall. Additional factors, coupled with this loss of normal propulsive activity, may be putrefaction of colonic contents and excessive diffusion of gas through the raw, granulating mucosal surface. That putrefaction and diffusion rather than swallowed air may be the major source of gas is suggested in two cases of our group (W. A. and J. B.). Following ileostomy (Fig. 6), in which there had been complete ileal transection, persistence of marked distention of the colon paralleled by continued evidence of fulminant disease has been observed.

PROGNOSIS

The mortality rate is high in fulminating colitis, with perforation of the colon as

plain film of the abdomen in a case of fulminating colitis fail to demonstrate some colonic abnormality.

The precise mechanism of the striking



Fig. 5. S. M. Supine abdominal film. Distended colon from cecum to splenic flexure; nodular mucosal thickening particularly evident in cecum and ascending portion (upper arrows); semilunar folds almost entirely effaced in transverse colon; thickened bowel wall (lower arrows).

the usual cause of death. Lumb *et al.*(8) reviewed 7 cases of fulminating colitis associated with distention of the colon, in 3 of which acute perforation developed. They suggested that dilatation was associated with perforation. Ripstein (11) considered "a distended segment of colon without small bowel distention" an indication of impending perforation. Bockus (2) comments on the frequent association of perforation with fulminating colitis, adding, "unfortunately abdominal distention and/or signs of local peritoneal irritation often antedate the occurrence of free perforation and the reaction to a free perforation under such circumstances may not be so dramatic."

In Crile's (6) experience approximately one-third of the patients with fulminating colitis died during their first admission. He considered distention of the colon to be a grave prognostic sign, often signifying impending perforation. He also found a mortality of 50.5 per cent in reported cases of fulminating colitis treated by ileostomy, the major cause of death being perforation

of the bowel. Crile advocates colectomy as the immediate treatment, arguing that the hazard of perforation is much greater than the hazard of the operation even in an acutely ill patient.

Of the 26 patients in the present series, 6 died during the acute episode, and in 2 others perforation occurred but emergency colectomy proved to be life-saving.



Fig. 6. R. F. Supine film of abdomen, sixteen days post-ileostomy. Distention of transverse colon with nodular changes. Persistence of colonic distention after ileostomy, there being no ileocolic communication, implies continued fulminating disease.

DIFFERENTIAL DIAGNOSIS

The diagnosis of fulminating colitis can be made with considerable certainty in those cases in which the plain abdominal film reveals a colonic distention in addition to the alterations in the bowel wall described above. When distention alone is seen, it cannot be distinguished from mechanical or paralytic ileus of other origin, and a radiologic diagnosis may be obtained only by means of a careful barium study of the colon. If, however, there is clinical evidence of active colitis, the demonstration of a markedly distended colon on a plain abdominal film should be

considered as possible evidence of severe colitis.

The case of an adult male with a history of ulcerative colitis, twice exhibiting acute symptoms and on each occasion found to have a distended colon, was reported by Marshak (10) as acquired megacolon complicating ulcerative colitis. The distention may have been a manifestation of a severe episode of colitis, but fulminating colitis has occasionally been mistaken for megacolon. Such a diagnostic error was reported by Lumb *et al.* and also occurred in one of our cases. Persistence of colonic distention after subsidence of symptoms might support a diagnosis of megacolon, but in our group the combination was not observed. On the other hand, in cases of fulminating colitis, colonic distention invariably subsided with improvement in the clinical state.

BRIEF SUMMARIES OF ILLUSTRATED CASES

P. M., white male, 61 years: Two days after total cystectomy for carcinoma, onset of bloody diarrhea and distention with increasing toxicity and ascites. Condition steadily deteriorated, with death in two weeks. Diagnosis of diffuse acute ulcerative colitis only established postmortem. No perforation.

F. P., white female, 27 years: Seven weeks of bloody diarrhea with two days of abdominal cramps and distention. Five days later acute perforation with emergency colectomy for diffuse acute colitis with subacute and acute perforations.

W. M., white male, 40 years: Increasing bloody diarrhea and abdominal cramps with fever for three and a half weeks. Palpable, distended transverse colon. No previous symptoms of colitis. Failed to respond to medical regime including antibiotics and ACTH. Total colectomy for diffuse severe colitis.

J. B., white male, 27 years: Second fulminating episode with first symptoms of colitis twenty-two months earlier. Virtually asymptomatic past twelve months. Ten days of fever, abdominal cramps, and bloody diarrhea. Condition rapidly improved under medical regime including ACTH, and distention subsided. Total colectomy for diffuse chronic ulcerative colitis a year later.

S. M., white female, 39 years: Mild symptoms of colitis for one and a half years. Increasing bloody diarrhea five weeks, with fever, anorexia, and vomiting for two weeks. Moderate distention with diffuse abdominal tenderness. Recovery on medical regime after two weeks hospitalization, with subsidence of distention.

R. F., white male, 42 years: Diarrhea for ten months with severe colonic bleeding; abdominal cramps and fever for three days. First symptoms of colitis twenty years ago. Transection type ileostomy without improvement and with continued abdominal distention. Subtotal colectomy for severe colitis. Cecum not involved.

SUMMARY

Distention of the colon was found to be present in 26 cases of fulminating ulcerative colitis. In addition, alterations in the bowel wall visible on plain abdominal radiographs were present in 16 of these cases and produced an appearance which is believed to be specific for this disease process.

While the clinical picture of fulminating colitis is fairly well documented, radiographic changes have received little attention. The fairly standard pattern of these abnormalities should be appreciated as well as their close correlation with the clinical and pathological aspects of this disease. This will make unnecessary further possibly harmful investigative procedures.

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SUMMARIO IN INTERLINGUA

Diagnose, A Pellicula Simple, De Fulminante Colitis Ulcerative

Le presentia de distension del colon esseva constatate in 26 casos de fulminante colitis ulcerative. In plus, alterationes in le pariete intestinal, visibile in simple radiographias abdominal, esseva presente in 16 de iste casos, producente un apparentia que es considerate como specific pro iste processo pathologic. Iste characteristics radiographic reflecteva le morbide alterationes anatomic de distension e accurtamento del colon, un spissification irregular del pariete intestinal, nodular

elevation mucosal, e interjacente areas de tenuification o ulceration.

Durante que le tableau clinic de colitis fulminante es satis ben documentate, le alterationes radiographic in ille condition ha recipite pauc attention. Le relative-mente uniforme configuration de iste anormalitates deberea esser recognoscite, e etiam lor stricte correlation con le aspectos clinic e pathologic del morbo. Isto rende innecessari le effectuation de altere e possibilemente nocive mesuras investigatori.



Why Selective Angiography?

Technic and Applications in the Preoperative Evaluation of Patients with Congenital and Acquired Heart Disease¹

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THE ROLE OF the radiologist in the preoperative evaluation of patients with congenital or acquired heart disease is an increasingly important one. With the widespread application of direct-vision surgical technic, he may no longer be satisfied with the mere classification of a lesion but is frequently called upon to specify its anatomic site and to draw conclusions as to its physiologic sequelae. Such precise knowledge is essential to intelligent surgical planning. Catheterization of the right and left sides of the heart furnishes much valuable information (1), but the results of such studies may often be indirect or inferential. The sites of origin and termination and the approximate magnitude of circulatory shunts can be determined in most instances by this means, but the specific type of anatomic defect responsible for the shunt must ordinarily be deduced from clinical findings viewed in the light of past experience. For example, a coronary arteriovenous fistula and an aneurysm of the sinus of Valsalva ruptured into the right atrium both result in left-to-right shunts originating in the proximal aorta and terminating in the right atrium, but the indications for operation and the surgical technics to be employed are quite different. Only with direct visualization by contrast radiography can the two conditions be conclusively differentiated before operation.

Although radiographic visualization of the cardiac chambers and great vessels is usually possible following the intravenous injection of a contrast medium, the disadvantages of this method are becoming increasingly apparent. The medium is frequently diluted in its passage through

the circulation to such an extent that insufficient contrast is obtained for precise diagnosis. This is particularly true when the heart is large, when venous stasis exists, or a left-to-right shunt is present. The left atrium, left ventricle, and aorta frequently are poorly visualized following intravenous injection. Furthermore, the medium reaches the heart in a stream rather than as a discrete bolus, and several chambers are often opacified more or less simultaneously. Although all these and other disadvantages of intravenous angiography are well documented in the European literature (2-4), the procedure is still widely employed in America.

The term "selective angiography," as used in this paper, refers to introduction of a contrast substance directly into the central circulation by means of a cardiac catheter. In the present study, selective injections were made into the heart, pulmonary artery, or ascending aorta. The opaque medium was thus delivered in high concentration at the site deemed most likely to reveal the lesion. When certain precautions were observed, the procedure was found to be safe and to furnish diagnostic information not obtainable by any other means. More than 200 radiographic examinations with selective injection have been carried out at the National Institutes of Health. The present report details the technics employed and their application in the evaluation of a variety of congenital and acquired cardiovascular defects.

TECHNIC

Injections into the Heart or Pulmonary Artery: The site of injection, dose of contrast material, and the timing of the radio-

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graphic exposures are dependent upon the cardiovascular anomaly known or suspected to be present. In all instances, a complete right-heart catheterization is performed before the angiocardigram is planned. In selected patients, particularly those with pulmonic stenosis and an intact ventricular septum, the injection is made at the conclusion of the diagnostic catheterization. In most instances, however, the studies are not made concurrently.

A modified Lehman catheter is always employed for injections.⁴ This is a thin-walled catheter with a closed end and four side openings spirally placed proximal to the tip. This design minimizes both recoil and forward movement of the catheter during the course of the injection. Patients are prepared by abstinence from food and fluids for a minimum of six hours. They are premedicated with Demerol, scopolamine, and an oral barbiturate one hour before the procedure. Local anesthesia is ordinarily employed for exposure of the saphenous or antecubital vein, although light general anesthesia (Pentothal) is sometimes necessary in infants and young children. The catheter is passed under fluoroscopic control to the previously selected site in the heart or pulmonary artery. Throughout the catheterization and subsequent injection an electrocardiogram is visually monitored on an oscilloscope and recorded at intervals. Correct placement of the catheter is facilitated by measurement of the intracardiac pressures, and for this purpose a portable system of pressure transducers, amplifiers, and a direct writing oscillograph is used.

For injections into the right ventricle (*e.g.*, pulmonic stenosis, tetralogy of Fallot, interventricular septal defect with right-to-left shunt), the catheter tip is positioned in the outflow tract proximal to the area of obstruction. Occasionally, the catheter is directed toward the apex of the ventricle. Pulmonary artery injections (*e.g.*, pulmonary vascular lesions and left heart lesions with atrial and ventricular

septa intact) are always made with the catheter tip vertically placed in the main pulmonary artery. For injections into the left ventricle (*e.g.*, varieties of common atrioventricular canal, atrial septal defect, and ventricular septal defect) the catheter is passed from the saphenous vein, across the atrial septum into the apex of the left ventricle.

After the catheter has been positioned, the patient is transferred to the angiocardigraphic table and biplane scout films are made to check the exposure factors and verify the catheter position. Should further manipulation of the catheter be necessary, it is imperative that additional scout films be made immediately before the injection is carried out.

A 70 per cent solution of Urokon has been the only contrast material employed in this study, with a dose of 1.0 c.c./kg. body weight accepted as standard. This dose is reduced when right ventricular injections are made in the presence of an intact ventricular septum and may be increased when there is evidence of a right-to-left shunt. The medium is introduced by means of a Gidlund (Elema) power injecting syringe (5). This apparatus provides an injection pressure of 10 kg./sq. cm. and allows the injection of 50 c.c. of 70 per cent Urokon through a No. 9 catheter in less than one second.

When the position of the catheter has been verified radiographically, anesthesia is induced by an intravenous injection of Sodium Pentothal and succinylcholine. Immediately before and after the injection the patient is hyperventilated with 100 per cent oxygen, and during the injection he is held apneic in full inspiration.

Films are exposed in the anteroposterior and lateral projections at the rate of three to six per second. Oblique projections are occasionally obtained when deemed advantageous. Varying intervals of exposure and delays in the film sequence are used as indicated by the individual study. The radiographic apparatus consists of two Westinghouse 500-ma controls and two 500-ma generators in conjunction with a

⁴ Manufactured by the U. S. Catheter and Instrument Co., Glens Falls, N. Y.

Schönander biplane film changer. The film is Eastman Kodak Blue Brand medical x-ray film, size 14 × 14 inches. Exposure times vary from 1/60 second at 500 ma and 80 kvp in infants up to 1/15 second at 300 ma and 120 kvp in large adults. Cross-hatch grids are used to reduce radiation scatter to a minimum and hence provide better detail.

After completion of the study, the catheter is withdrawn, the vein is ligated, and the wound is closed. Penicillin is given intramuscularly for forty-eight hours. Repeat injections are avoided whenever possible and are never performed at intervals of less than thirty days.

Injections into the Ascending Aorta: Aortic injections are always made with the catheter tip in the ascending aorta immediately above the aortic valve. Ordinarily, an incision is made in the right forearm and the brachial artery and its ulnar and radial branches are exposed. The larger of the two branches is incised longitudinally and the catheter introduced. Extreme care must be taken that the brachial artery itself is not damaged and that the intima of the vessel is not caught and stripped by the catheter tip. In children less than five years of age, the common femoral artery or its superficial branch is ordinarily employed. As the catheter passes into the aorta, fluoroscopy is done with the patient in the semilateral position to determine that the catheter is passing anteriorly into the ascending aorta rather than posteriorly into the descending aorta. Left ventricular injections may be made by this approach if the catheter can be manipulated through the aortic valve. The radiographic and anesthetic techniques in aortography are similar to those employed with intracardiac injections. At the conclusion of the study, the arteriotomy is carefully repaired with a continuous suture of 5-0 silk.

Urokon 70 per cent in doses of 1.2 c.c./kg. body weight is ordinarily employed for aortography. However, a total dose of 55 c.c. is seldom exceeded unless there is firm evidence of aortic insufficiency or a

left-to-right shunt originating from the aorta. In these circumstances, doses up to 70 c.c. have been used in adults. Careful positioning of the catheter in the ascending aorta insures that the medium will be completely mixed with blood and will not reach the cerebral circulation in high concentration. Carotid compression is not utilized.

RESULTS AND DISCUSSION

Selective injections of a contrast medium have been carried out in over 200 patients with a variety of congenital and acquired cardiovascular defects. No deaths have resulted from either selective aortography or angiocardiology. The most serious complication occurred early in the series, when ventricular fibrillation developed after injection in a thirty-one-year-old female with mitral stenosis. The arrhythmia followed the injection of 55 c.c. of 70 per cent Urokon into the right atrium. Normal rhythm was restored by cardiac massage and electrical defibrillation carried out in the x-ray department. The patient was then moved to the operating room, where a mitral commissurotomy was performed. Her subsequent course has been uneventful. The injection in this instance was carried out with only local anesthesia in a heavily sedated and probably poorly oxygenated patient. This experience serves to emphasize the role of good general anesthesia in providing adequate ventilation and abolishing vagal reflexes.

One patient experienced right pleuritic pain and hemoptysis after the injection of 60 c.c. of Urokon into the pulmonary artery. A scout film had shown the catheter tip to be outside the heart shadow in the right pulmonary artery. The catheter was withdrawn 4 inches and the injection was made without verification of the position of the tip, which remained at its original site. Subsequent films demonstrated diffuse opacification of the right lung, which cleared in seven to ten days. This complication was directly attributable to improper placement of the catheter and indicates the absolute necessity for precise

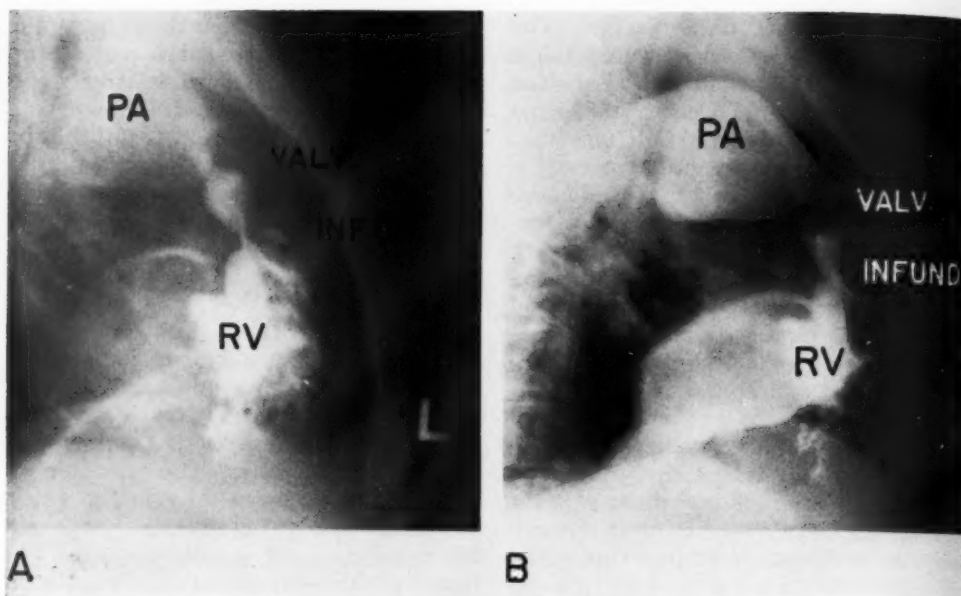


Fig. 1. Pulmonic stenosis with intact ventricular septum.

A. Lateral projection with the right ventricle in systole. A jet of contrast material is seen passing through the stenotic valve (Valv.) and narrowed infundibulum (Infund.)

B. Later film, in diastole, again showing the fixed pulmonic valve and indicating that the infundibular narrowing is persistent. There is poststenotic dilatation of the pulmonary artery and contrast medium regurgitates into the right atrium from the ventricle.

localization of the catheter tip immediately prior to the injection.

Electrocardiographic abnormalities, with the exception noted above, have been transient. With right-heart injections, four or five premature ventricular contractions are usually seen. The ventricular rate may slow for a few seconds, particularly in the presence of pulmonic stenosis. Injections into the aorta and left ventricle have been noteworthy for the lack of associated electrocardiographic changes. In 2 infants there was extravasation of the contrast material into the right ventricular myocardium after right ventricular injection, but no symptoms or electrocardiographic changes were manifested. In 2 adults a small quantity of contrast material likewise entered the myocardium, again without significant reaction.

CLINICAL ILLUSTRATIONS

Selective angiocardiography and thoracic aortography have been found of particular

value in the assessment of certain forms of congenital and acquired heart disease. The following cases are representative of the types of abnormalities in which the technic of selective injection is of special usefulness.

Pulmonic Stenosis with Intact Ventricular Septum: E. A., a boy aged 12, presented the classic clinical findings of pulmonic stenosis. Cardiac catheterization revealed a mean pulmonary artery pressure of 15 mm. Hg and a right ventricular pressure of 250/16 mm. Hg. As the catheter was withdrawn from the pulmonary artery into the right ventricle, the pressure change was abrupt and it was concluded that the obstruction was at the level of the pulmonary valve. The selective angiocardiogram (Fig. 1), however, revealed a severe degree of infundibular as well as valvular stenosis. The study indicated the necessity of a combined pulmonary valvulotomy and infundibular resection, which was subsequently carried out.

Little confidence may be placed in the configuration of the pressure tracings in differentiating valvular and infundibular pulmonic stenosis. As the catheter is withdrawn, the valve may impinge upon its tip

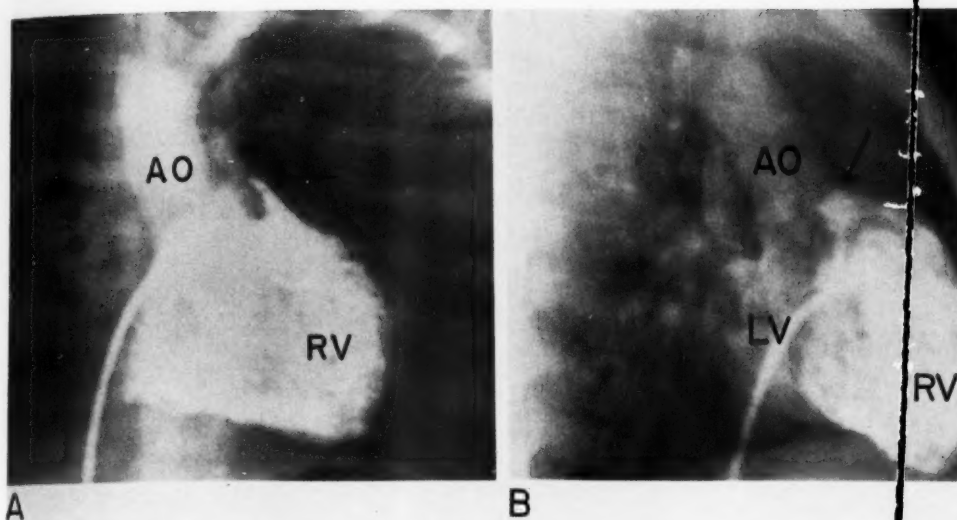


Fig. 2. Pulmonary atresia.

A. Anteroposterior projection showing atresia of the outflow tract of the right ventricle and early filling of the aorta (AO).

B. Lateral projection again demonstrating pulmonary atresia and a ventricular septal defect through which the left ventricle (LV) and aorta are filled. The atretic outflow tract is indicated by an arrow in each view.

and the resulting artefacts in the tracing may be indistinguishable from the zone of intermediate pressure characteristic of subvalvular stenosis. The frequency with which both lesions are present further compounds the diagnostic problem. Selective angiocardiology is considered to be the only reliable method by which an accurate preoperative assessment of the lesion is possible.

Pulmonic Stenosis with Right-to-Left Shunt: J. H., a 21-month-old child, had been cyanotic from birth. There was a faint systolic murmur at the base of the heart and roentgenograms revealed right ventricular hypertrophy, concavity in the region of the pulmonary conus, and diminished pulmonary vascularity. Right ventricular selective angiocardiology (Fig. 2) demonstrated atresia of the outflow tract of the right ventricle and filling of the pulmonary arteries from collateral channels. The diagnosis of pulmonary atresia (pseudo-truncus arteriosus) was confirmed at operation, at which time a subclavian-pulmonary anastomosis was performed.

The specific anatomy of the tetralogy of Fallot can best be delineated by selective angiocardiology with right ventricular injection. Careful preoperative study is

becoming of increasing importance as more children with this defect are being offered completely corrective operations with the aid of extracorporeal circulation. The degree of infundibular narrowing, the presence or absence of associated valvular stenosis, the relation of the aorta to the ventricular septum, and the anatomy of the aortic and pulmonary arterial branches must all be considered in preoperative planning. Although differentiation of the tetralogy from tricuspid atresia and the "Eisenmenger complex" can usually be accomplished by other means, the angiocardiological picture of each is characteristic. In the patient described, the angiocardiology demonstrated preoperatively the lack of communication between the right ventricle and the pulmonary artery and established the necessity for an indirect operation instead of an effort at complete correction.

True Truncus Arteriosus: S. W., an 8-year-old boy, had had a heart murmur since birth and his growth and development had been markedly retarded. He was slightly cyanotic, and a loud continuous murmur was audible over the base of the heart. An aortogram (Fig. 3) revealed the presence

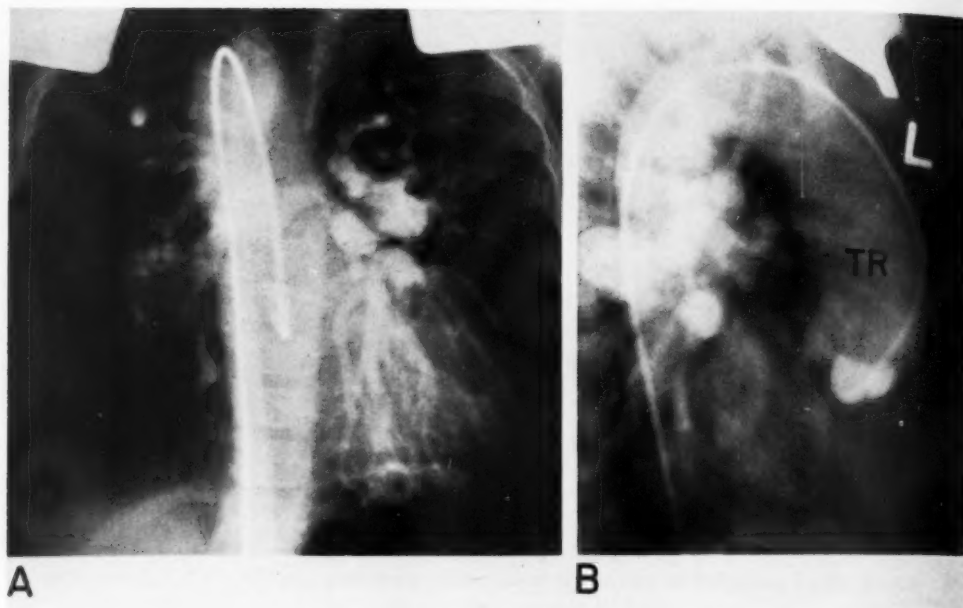


Fig. 3. True truncus arteriosus.

- A. Anteroposterior projection demonstrating origin of "pulmonary arteries" from the descending aorta.
 B. Lateral projection. The common trunk arising from the base of the heart (TR) gives off tortuous pulmonary vessels posteriorly.

of a true truncus arteriosus and "pulmonary arteries" to each lung were seen to arise by a common trunk from the descending aorta. The child's difficulties were attributed to increased pulmonary blood flow and he was treated by operative constriction of the aortic branches which served as pulmonary arteries.

Differentiation of the varieties of truncus arteriosus from other lesions resulting in a continuous murmur and increased pulmonary flow is essential. Although completely corrective operations for these lesions are yet to be developed, contrast examinations are of importance in distinguishing true truncus from patent ductus, aortic pulmonary window, and the other correctable left-to-right shunts at the base of the heart. In the patient described, the common origin of the pulmonary and systemic circulation was clearly demonstrated and an opportunity was afforded for the type of operative treatment described.

Pulmonary Arteriovenous Fistula: D. S., a 13-month-old girl, had been cyanotic and dyspneic

since birth. There was a to-and-fro murmur over the left posterior chest wall accentuated by exercise. An oval density was seen in the left lower lobe on routine roentgenograms. Selective angiocardiology with right ventricular injection was carried out (Fig. 4). This revealed a large pulmonary arteriovenous fistula with the formation of an aneurysm. The lesion was confined to the lower lobe, which was subsequently resected. This patient was one of those in whom the medium was inadvertently injected into the wall of the right ventricle with no untoward effects.

The diagnosis of pulmonary arteriovenous fistula can ordinarily be made with ease. Before surgical treatment is contemplated, however, a knowledge of the lobar or segmental distribution of the lesion is essential. The fistulas are multiple in nearly one-third of patients, and additional small fistulas in another lobe or the opposite lung may easily be overlooked. Selective bilateral pulmonary angiography furnishes the most precise information as to the extent of pulmonary resection that will be necessary and the presence of unrecognized fistulas. Injection of the contrast medium

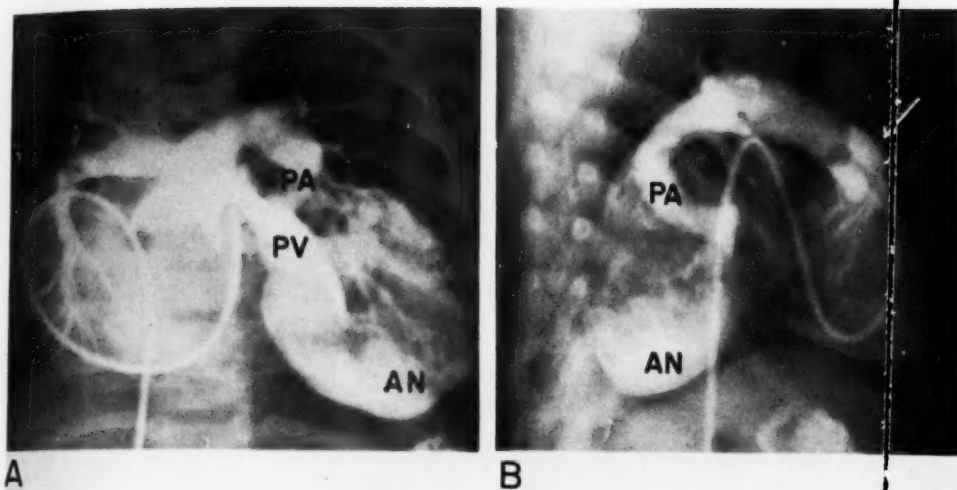


Fig. 4. Pulmonary arteriovenous fistula.

A. Anteroposterior projection demonstrating a large aneurysm (AN) in the left lower lobe. It is supplied by an enormous lobar artery (PA) and drained by a vein of similar size (PV).
 B. Lateral projection. The fistula is again seen and contrast medium has extravasated into the outflow tract of the right ventricle (arrow).

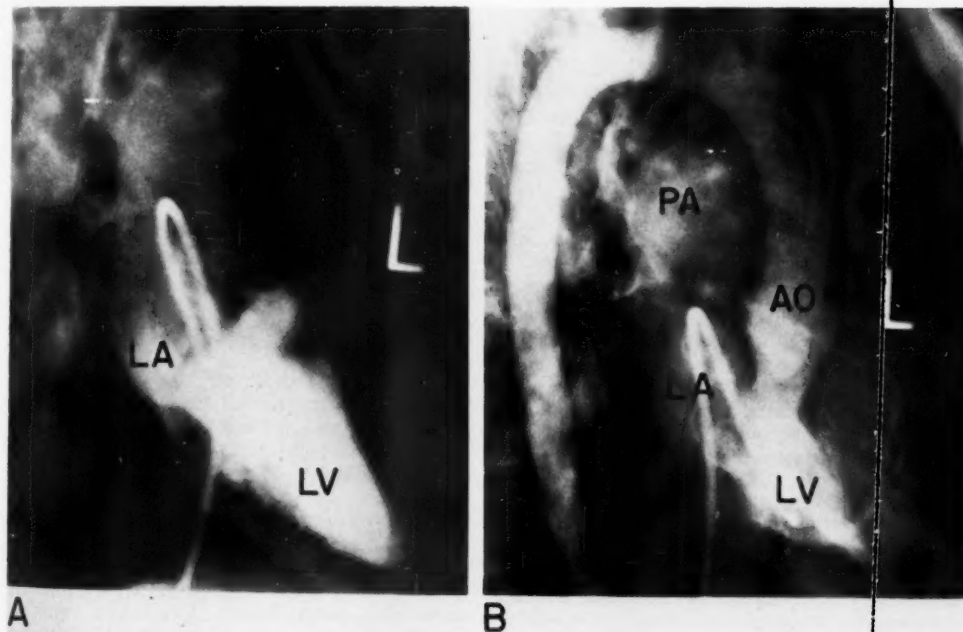


Fig. 5. Incomplete atrioventricular canal ("ostium primum" type) of atrial septal defect with incompetent mitral valve).

A. Early lateral view. Urokon has been injected into the left ventricle (LV). There is immediate opacification of the left atrium (LA) via an incompetent (cleft) mitral valve.
 B. Later lateral film with opacification of the aorta (AO) and residual contrast medium in the left atrium and left ventricle. The pulmonary artery (PA) has now been filled by Urokon passing back through the mitral valve, across the interatrial septum, and into the right heart.

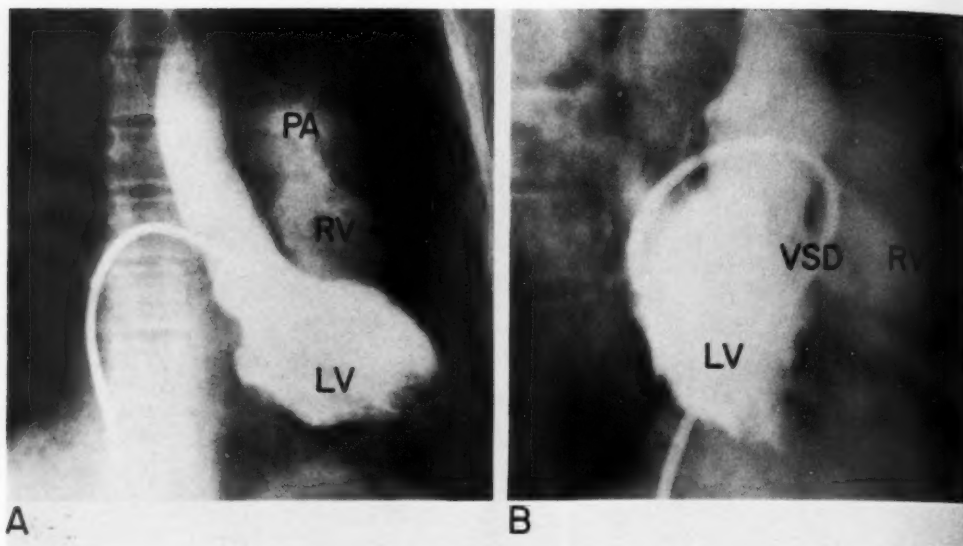


Fig. 6. Ventricular septal defect.

A. Anteroposterior projection following selective left ventricular injection. There is immediate filling of the outflow tract of the right ventricle (RV) and the pulmonary artery (PA). The right atrium is not opacified.

B. Lateral projection demonstrating the ventricular septal defect (VSD).

directly into the main pulmonary artery just proximal to its bifurcation affords the greatest concentration of the opaque medium in the pulmonary circulation and hence the best visualization of vascular abnormalities.

Atrial Septal Defect and Varieties of Persistent Atrioventricular Canal: V. C., a 39-year-old man, had had a heart murmur since birth and increasing exertional dyspnea and fatigability. Right heart catheterization revealed the presence of a left-to-right shunt at the atrial level. The electrocardiogram, however, showed left as well as right ventricular hypertrophy and there was an unusually loud systolic murmur near the apex. These data suggested the presence of some form of persistent atrioventricular canal. A catheter was passed from the saphenous vein, through the atrial defect, into the left ventricle, and 50 c.c. of 70 per cent Urokon was injected. The films (Fig. 5) showed the medium passing through an incompetent mitral valve into the left atrium, and later films of the series demonstrated opacification of the right atrium, right ventricle, and pulmonary artery.

The diagnosis of an atrial septal defect of the so-called ostium primum type was established and the presence of a ventricular component of the shunt was excluded. Differences of oxygen content

in the cardiac chambers and the use of nitrous oxide test (6) indicate only the site at which a left-to-right shunt terminates. Indicator dilution curves following left heart injection (7) give information as to the origin of the shunt only. Injections of a contrast medium directly into the left ventricle have proved of particular value in the differentiation of ventricular septal defect, mitral insufficiency, atrial septal defect, and conditions in which these defects occur in combination.

Ventricular Septal Defect: C. S., a 15-year-old girl, was not cyanotic but had had repeated pulmonary infections and was dyspneic on mild exertion. Her heart was enlarged and the electrocardiogram revealed marked right ventricular hypertrophy. Right-heart catheterization demonstrated a large left-to-right shunt at the atrial level. There was an equivocal further increase in oxygen and N_2O content of the blood in the right ventricle (0.5 volume per cent), suggesting the presence of an associated ventricular septal defect. A selective injection into the left ventricle (Fig. 6) confirmed the presence of a ventricular septal defect; the mitral valve was competent.

When a large left-to-right shunt into the right atrium is present, it may be difficult to detect a more distal shunt, as

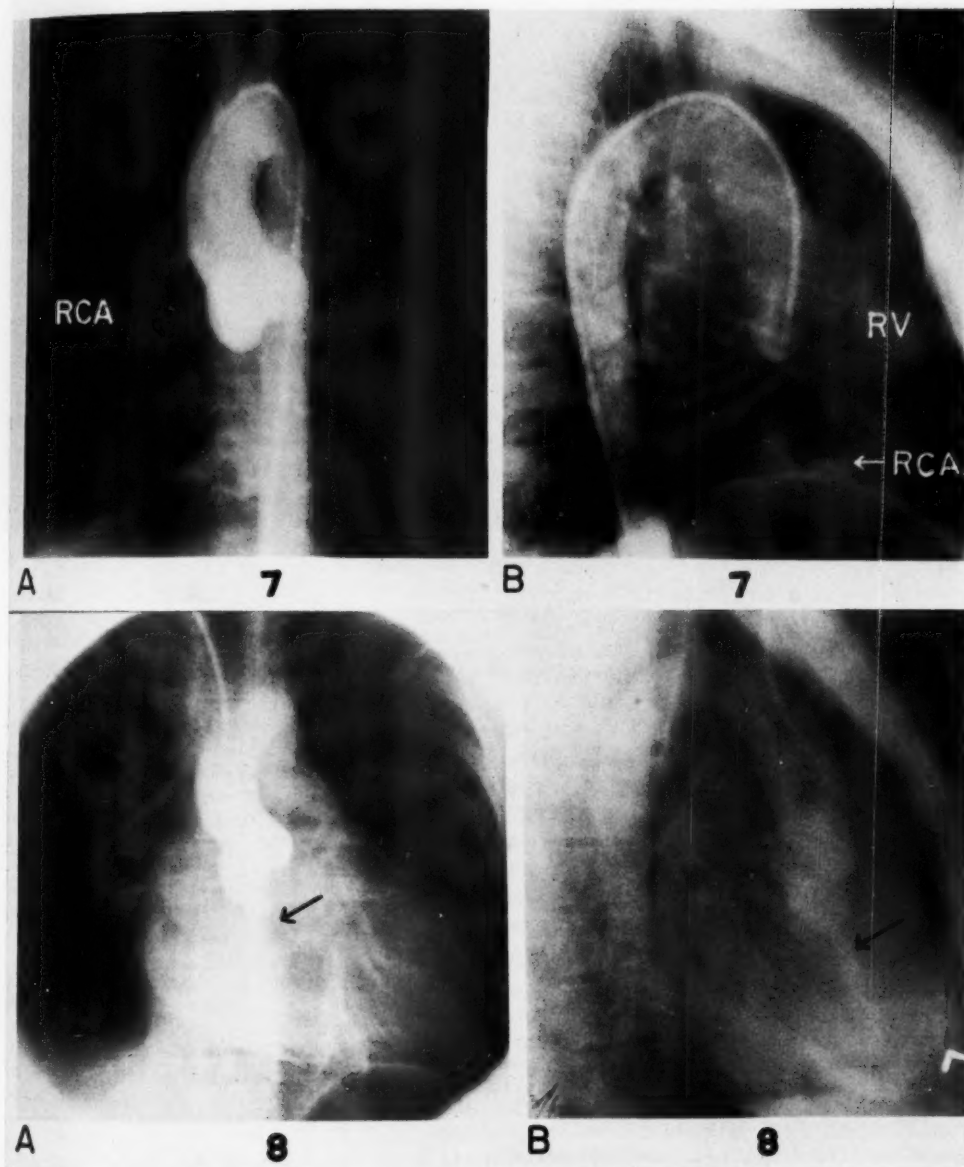


Fig. 7. Communication between the right coronary artery and the right ventricle.

A. Anteroposterior aortogram showing a large, tortuous right coronary artery (RCA) which empties into the right ventricle near the tricuspid valve.

B. Lateral projection. The dilatation and tortuosity of the anomalous artery are again seen, as well as contrast material in the outflow tract of the right ventricle (RV).

Fig. 8. Rupture of an aneurysm of the sinus of Valsalva into the right atrium.

A. Anteroposterior aortogram. There is rupture of the noncoronary sinus. A jet of contrast material is seen passing into the right atrium proximal to the tricuspid valve.

B. Lateral projection showing the sinus tract and jet of contrast material. The aortic sinus is enlarged and deformed.

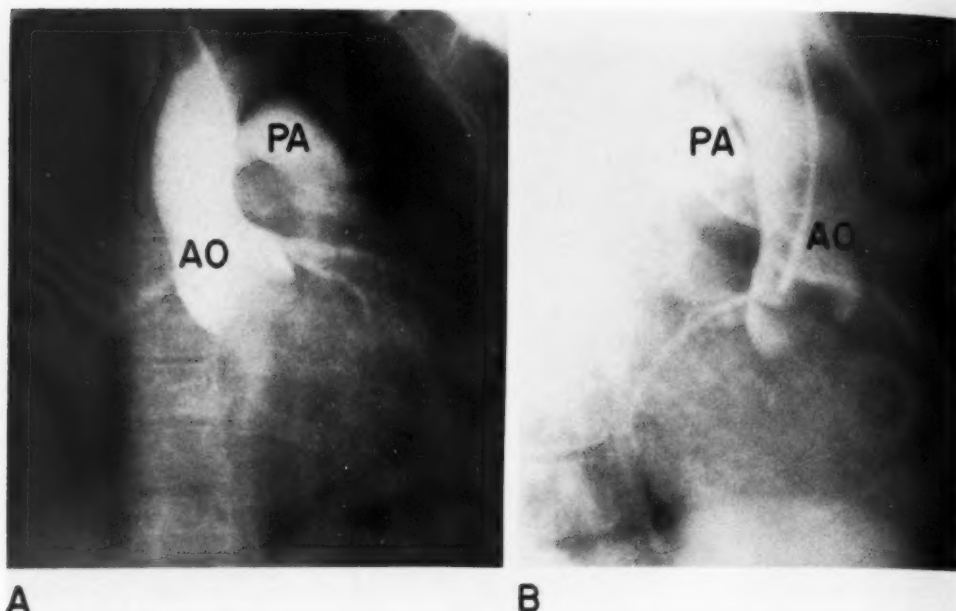


Fig. 9. Aortico-pulmonary window.

A. Anteroposterior selective aortogram demonstrating a communication between the ascending aorta (AO) and the main pulmonary artery (PA). The fistula is an unusually high one.

B. Lateral projection. There is opacification of the pulmonary artery before medium in the aorta has reached the descending arch.

the oxygen content of blood in the ventricle and pulmonary artery is already close to the arterial level. The knowledge, before operation, as to whether a ventricular septal defect accompanies a proved atrial defect is of importance in determining the operative approach and may obviate the necessity of an exploratory right ventriculotomy.

Left-to-Right Shunts Originating from the Aorta.

A. Communication between the Right Coronary Artery and the Right Ventricle: F. P., a 29-year-old housewife, had no symptoms of heart disease, but a heart murmur had been present since birth. The murmur was continuous and "machinery-like" but was loudest along the left of the sternum in the fourth intercostal space. Cardiac catheterization and nitrous oxide tests revealed a small left-to-right shunt into the right ventricle. The selective aortogram (Fig. 7) demonstrated an enlarged and tortuous right coronary artery from which contrast material passed into the right ventricle. Since the patient remains asymptomatic, no operation has been performed.

B. Rupture of Aneurysm of Sinus of Valsalva: N. H., a 27-year-old soldier, was well until he sud-

denly experienced the onset of chest pain and dyspnea. Right heart failure ensued and a loud continuous murmur was audible over the precordium. Cardiac catheterization revealed a large left-to-right shunt into the right atrium. An aortogram (Fig. 8) confirmed the diagnosis of aneurysm of the sinus of Valsalva ruptured into the right atrium. The physiologic studies in this patient and the technique of surgical correction employed have been reported elsewhere in detail (8).

C. Aortico-Pulmonary Window: H. C., a 14-year-old schoolboy, presented with cardiomegaly and a loud continuous murmur in the left second intercostal space. The electrocardiogram revealed left ventricular hypertrophy, and a large left-to-right shunt into the pulmonary artery was demonstrated by cardiac catheterization. An aortogram (Fig. 9) disclosed a communication between the ascending aorta and main pulmonary artery. The defect was successfully divided and closed with the aid of general hypothermia.

D. Patent Ductus Arteriosus: S. S., a 39-year-old housewife, was asymptomatic. Except for a faint continuous murmur over the upper left precordium, the physical findings were normal. At right-heart catheterization, there was no detectable increase in the oxygen content of pulmonary artery

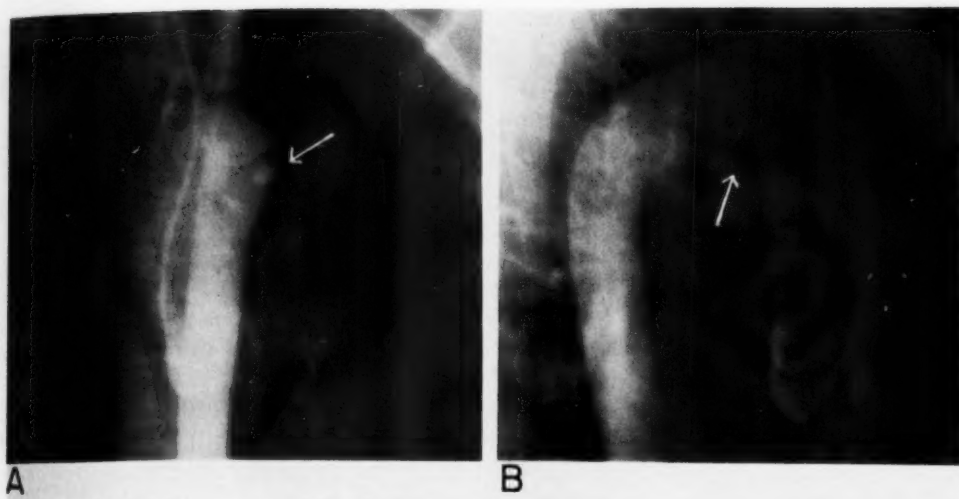


Fig. 10. Patent ductus arteriosus.

A. Anteroposterior selective aortogram. The small patent ductus is here visualized end-on (arrow).
 B. Lateral projection. The ductus is clearly shown and the arrow indicates its narrow termination at the pulmonary artery.

blood, and nitrous oxide tests in the pulmonary artery were considered equivocal (11.4 and 12.8 per cent). A thoracic aortogram (Fig. 10) revealed a patent ductus which was greatly narrowed at its entrance into the pulmonary artery.

These 4 patients with left-to-right shunts originating from the aorta serve to illustrate the variety of lesions that may be encountered when a patient presents with a continuous murmur at the base of the heart. The importance of an exact anatomic diagnosis is obvious, as the prognosis, the indications for correction, and surgical techniques for these conditions are different. Closure of a patent ductus arteriosus, for example, is an operation without significant risk and one which can be carried out by any competent thoracic surgeon in a community hospital. Closure of an aortico-pulmonary window or ruptured sinus of Valsalva aneurysm, on the other hand, entails elaborate preparation and the utilization of the highly specialized techniques of general hypothermia or extracorporeal circulation. When a patient with a "patent ductus" has a murmur of unusual character or in an atypical position, the presence of a different variety of left-to-right shunt should be suspected. Under

these circumstances, thoracic aortography is certainly to be preferred to exploratory thoracotomy, an operation performed all too frequently as a diagnostic measure.

SUMMARY

Selective injections of contrast medium into the heart, pulmonary artery, or ascending aorta were carried out in more than 200 patients with a variety of congenital and acquired cardiovascular lesions. The technic was found of particular usefulness in the study of patients with pulmonic stenosis, pulmonary vascular lesions, atrial septal defect, ventricular septal defect, varieties of persistent atrioventricular canal, and left-to-right shunts originating from the aorta. The techniques of catheterization, anesthesia, injection, and radiography are presented, and the value of such selective contrast studies is illustrated by selected clinical examples.

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SUMMARIO IN INTERLINGUA

Cur Angiographia Selective? Technica E Application In Le Evalutation Preoperatori De Patientes Con Congenite E Acquirite Morbo Cardiac

Injectiones selective de medio de contrasto in corde, arteria pulmonar, o aorta ascendente esseva effectuate in plus que 200 patientes con un varietate de congenite e acquirite lesiones cardiovascular. Le technica se provava specialmente utile in le studio de patientes con stenosis pulmonic, lesiones pulmono-vascular, defecto atrio-

septal, defecto ventriculo-septal, varie typos de persistentia del canal atrioventricular, e shuntings sinistro-dextere con origine in le aorta. Le technica de catheterismo, anesthesia, injection, e radiographia es presentate. Le valor de tal selective studios a contrasto es illustrate per le citation de exemplos clinic.



The Importance of the Air Shadow of the Cisterna Magna in Encephalographic Diagnosis¹

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THE CISTERNA magna frequently is the site of clinically obscure lesions that do not increase the intracranial pressure and that can be outlined by pneumoencephalography. Little has been written on this subject because, as a rule, neurological surgeons have preferred to use ventriculography in cases of suspected surgical lesions and, in addition, unless a special effort is made, the cisterna magna is seldom visualized. The value of pneumoencephalography in this respect is demonstrated by the analysis of an experience of one year to be presented here.

PRECAUTIONS

In our institution, pneumoencephalography in itself has always been regarded as a surgical procedure. Therefore, the positioning of the patient, the induction of anesthesia, the injection of air, the radiography, the development and the examination of the films, all are carried out on the operating floor, where every surgical and anesthetic facility is at hand. Sterile packs of instruments for craniotomy and for ventricular tap are kept available at all times. If signs of increased intracranial pressure are present, the instruments are laid out and the scalp is prepared for craniotomy before the spinal air injection is started. The films are processed in a rapid developer; they are examined in the wet state and, if a surgical lesion is disclosed, the patient is kept under continuous observation in the surgical pavilion until the operation has been performed.

When papilledema is present and obstructive hydrocephalus is suspected, encephalography is seldom employed and

never without a preceding ventricular tap to relieve the intracranial tension. The technique of performing emergency ventricular tap has been simplified so that a cannula can be introduced into the ventricle within two minutes should indications arise. With this planning and these precautions, emergency situations will seldom develop. Over a period of twenty-eight years pneumoencephalography has proved, in our experience, to be a safe procedure and has disclosed many surgical lesions which could not have been diagnosed by any other method short of exploratory craniotomy. To employ ventriculography in place of encephalography in cases of suspected cerebral tumor *without increased intracranial pressure*, is not in the patient's best interest. Neither encephalography nor ventriculography, for that matter, should be undertaken without the precautions described above, since an expanding lesion will occasionally be disclosed even under the most unlikely circumstances. This possibility plus the hazards inherent in the use of any anesthetic agent can lead to disaster, if circumstances do not permit prompt counter measures.

TECHNIC

Thiopental (Pentothal) sodium is the anesthetic agent usually employed. Ten milliliters of air is introduced before starting the removal of fluid, and thereafter the fluid is replaced with air in 5-ml. amounts, with pressure readings at frequent intervals. We have found that the use of gases other than air offers little advantage. Unless there is some contraindication, the exchange is continued until air is recovered

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Fig. 1. Position for roentgenography of the cisterna magna. The tilted seat of the chair flexes the spine and, without restraining straps, holds the anesthetized patient securely in position. The head is flexed so as to increase the distance between the foramen magnum and the lamina of the atlas. A short exposure is essential in order to heighten the contrast.

from the needle. This is especially important if the cisterna magna is to be visualized. Scout films are made when indicated; anteroposterior, postero-anterior, and lateral films are always made before the patient is removed from the chair (Fig. 1). Only with the patient in the erect position can the basilar cisterns be adequately visualized and the projection of the lateral ventricles be compared on a single lateral film (Fig. 2). The horizontal position is essential only for demonstration of the temporal horns. To speed up the actual radiography, a head machine is employed in which the beam is constantly centered on the Bucky diaphragm. For adequate clarity, a rotating anode tube with a 1-mm. target is used as well as a fixed focal distance of 36 inches.

MATERIAL

During the year 1956, at the Cleveland Clinic Hospital, pneumoencephalography

was performed in 306 patients, ventriculography in 35, and arteriography in 245.

In 162 cases verified by craniotomy a pre-operative pneumoencephalogram had been obtained in 52. In 31 expanding supratentorial lesions in which the visualization was adequate, there was no demonstrable defect in the cisterna magna. In 15 of the

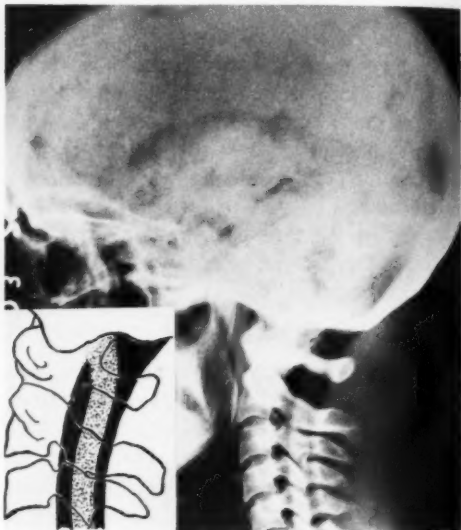


Fig. 2. Upright lateral roentgenogram centered on cisterna magna. The normal cisterna magna and spinal cord are clearly outlined on this film.

306 cases, the roentgen study led to the surgical exposure of the posterior fossa and in 10 of these the cisterna magna shadow was abnormal. In 7, an expanding lesion, either a tumor or hematoma, was revealed. In 1 instance a surgical lesion was not disclosed. In the remaining 7 there proved to be a Dandy-Walker syndrome, an Arnold-Chiari malformation, basilar impression, or syringomyelia. There is considerable evidence to show that these conditions may all be the result of an embryonal hydrocephalus produced by atresia of the fourth ventricle (1-6). This paper is concerned with the description of these 15 cases. All but 3 of the patients were adults.

CASE 1: The patient had been hospitalized for many weeks because of intractable vestibular vertigo. Encephalography was then performed, disclosing the findings of cerebellar tumor as described

by Gardner and Nosik (7) (Fig. 3). There was an absence of air in the ventricular system, the supracallosal sulcus was prominent although not bulging, and the shadow of the cisterna magna was obliterated by a cerebellar hernia. Operation disclosed a large hemangiomatic cyst of the left cerebellum.

CASE 2: The patient had cerebellar symptoms but no indication of increased intracranial pressure. Encephalography disclosed findings similar to those



Fig. 3. Case 1: Cerebellar neoplasm. There is no air in the ventricular system. The supracallosal sulcus is prominent, although not bulging. The shadow of the cisterna magna is obliterated by a cerebellar hernia.

of Case 1, and at operation a meningioma of the posterior fossa was removed.

CASE 3: As in Case 2, the patient had cerebellar symptoms with no indication of increased intracranial pressure. At encephalography the subarachnoid spaces were found to be entirely normal, but the absence of air in the ventricular system led to a surgical exposure that disclosed an astrocytoma of the medulla obstructing the foramen of Magendie.

In these 3 cases, the absence of bulging of the corpus callosum showed that there was little, if any, hydrocephalus. A ventriculogram, therefore, probably would not have been diagnostic.

CASE 4: Progressive bulbar symptoms were present, with no indication of increased intracranial pressure. Encephalography disclosed a typical picture of glioma of the pons (8), with normal lateral and third ventricles, posterior bulging of the floor of the fourth ventricle, and a narrowed pontine cistern. Operation revealed an astrocytoma of the pons.



Fig. 4. Case 5: Neurilemmoma of the cerebellopontine angle. A small cerebellar hernia can be identified in this otherwise normal encephalogram.

CASE 5: A 13-year-old girl was suspected of having pseudotumor cerebri because of failing vision and papilledema without headache or neurologic symptoms. Encephalography disclosed a normal picture that appeared to confirm the clinical diagnosis. Restudy of the films in the dry state, however, revealed herniation of the cerebellar tonsils into the cisterna magna (Fig. 4). This led to an exploration of the posterior fossa and the removal of a large neurilemmoma from the right cerebellopontine angle.

This case demonstrates that a neoplasm of the posterior fossa may produce papilledema without obstructive hydrocephalus.

CASE 6: The patient was admitted with symptoms of spontaneous subarachnoid hemorrhage of one week duration. Carotid arteriography disclosed a normal picture. Vertebral arteriography visualized only the extracranial portion of the artery. Encephalography revealed moderate ventricular dilatation, marked narrowing of the pontine cisterns, and a small foraminal hernia. These findings led to a suboccipital operation that disclosed a large intracerebellar hematoma resulting from a vascular hamartoma of the vermis.

It is doubtful that ventriculography would have been diagnostic in this case, since moderate ventricular dilatation is commonly seen in spontaneous subarachnoid hemorrhage of whatever source.

CASE 7: Symptoms present for five months were diagnosed as due to multiple sclerosis. Because of



Fig. 5. Case 7: Meningioma at the foramen magnum. The rounded mass occupies the cisterna magna and is superimposed on the shadow of the spinal cord.

Fig. 6. Photograph of a tumor similar to that in Case 7.

the absence of remission in the patient's illness, together with a slight increase in the protein content of the spinal fluid, an encephalogram was advised to determine whether there was a tumor at the level of the foramen magnum. The films disclosed a rounded mass projecting below the level of the foramen magnum (Fig. 5). At operation a meningioma was removed from this area (Fig. 6).

The attempt to delineate this tumor by Pantopaque myelography, if successful, would almost certainly have resulted in the trapping of a considerable quantity of the contrast medium within the skull.

CASE 8: A 3-year-old child had enlargement of the cranial vault and a bulging forehead. The outlines of the lateral sinuses were in the normal position and platybasia was present. At encephalography no air entered the ventricles, although the intracranial subarachnoid spaces were well outlined. Bulging of the supracallosal sulcus indicated severe hydrocephalus. The pontine cisterns appeared normal; the cisterna magna was small, but a filling defect could not be demonstrated. At operation, the fourth ventricle was found to be tremendously dilated and obstructed by a thin bulging membrane attached to the margins of the dilated foramen of Magendie. The diagnosis was congenital atresia of the foramina of Magendie and Luschka (9) (Dandy-Walker syndrome).

CASE 9: An infant of 7 months had hydrocephalus; indigo carmine injected into the lateral ventricle

was recovered in the spinal fluid within ten minutes. At encephalography, there was no air within the ventricles, although the intracranial subarachnoid spaces again were well outlined, showing narrowing of the pontine cisterns and bulging of the supracallosal sulcus. The shadow of the cerebellar tonsils reached the lamina of the first cervical vertebra. At operation a cerebellar hernia was disclosed, which was blocking the foramen of Magendie and represented an abortive Arnold-Chiari malformation.

CASE 10: The patient had cerebellar signs, papilledema, and incontinence of urine. Skull films disclosed basilar impression, with the tip of the dens 10 mm. above Chamberlain's line (1), and apparent assimilation of the atlas. Because basilar impression frequently is a sign of Arnold-Chiari malformation in the adult (2-6), the latter diagnosis was made. After relief of the intracranial pressure by ventricular tap, some air was introduced into the ventricles and encephalography was performed. The films disclosed dilated ventricles, narrowing of the pontine cisterns, and the outline of a posterior herniation of the medulla into the cisterna magna. At operation the medulla bulged posteriorly and was also dislocated caudally, as evidenced by the fact that the second cervical nerve roots pursued a cephalad course to their points of exit. The cerebellar tonsils were impacted in the foramen magnum, but did not protrude below it. The diagnosis was Arnold-Chiari malformation.

The combined injection of air into the ventricles and into the lumbar canal in the

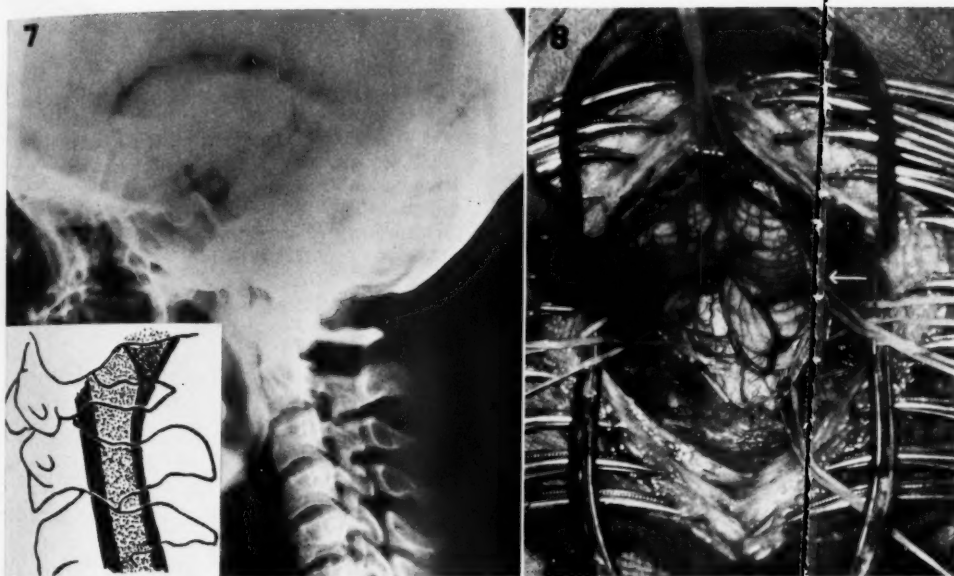


Fig. 7. Case 11: Arnold-Chiari malformation. The cerebellar hernia can be seen as a discrete shadow overlying the herniated medulla.

Fig. 8. Case 11. The herniated left cerebellar tonsil is retracted to disclose the bulging of the medulla. The looping vessel is the right posterior inferior cerebellar artery. Arrow indicates level of foramen magnum.

fashion described above may lead to confusion unless films are made in the interval between the injections. In this instance a simple ventricular tap to relieve pressure followed by encephalography would have disclosed, in addition to the posterior fossa findings, an absence of air in the ventricles and an upward bulging of the supracallosal sulcus. On the other hand, although air studies in this case were really not essential, ventriculography would have led to the correct surgical exposure.

CASE 11: There was in this case a history of bulbar speech of ten years duration and recent development of dysphagia. Roentgenograms demonstrated the presence of basilar impression, again suggesting the diagnosis of Arnold-Chiari malformation. Encephalograms disclosed a cerebellar hernia superimposed on a posterior bulging of the medulla (Fig. 7). Operation revealed herniated cerebellar tonsils reaching to the level of the first cervical lamina. The second cervical nerve roots pursued a somewhat cephalad course to their points of exit. Separation of the cerebellar tonsils disclosed a downward displacement and a posterior bulging of the lower medulla (Fig. 8). The diagnosis was Arnold-Chiari malformation.

Although in this case the diagnosis was

suggested by the findings in the skull films, it would not have been confirmed by ventriculography.

CASE 12: In this case the symptoms indicated a lesion at the level of the foramen magnum, believed to be multiple sclerosis or tumor. Encephalography disclosed absence of air in the ventricles with a normal intracranial subarachnoid system. No air could be seen from the level of the foramen magnum down to the lower border of the second cervical lamina. At operation a typical Arnold-Chiari malformation was found. The cerebellar tonsils had herniated to the lower border of the second cervical lamina. The second cervical nerve roots pursued a long cephalad course to their points of emergence. There was a posterior protrusion of the lower part of the medulla. The obex of the fourth ventricle reached the level of the lower border of the first cervical lamina.

CASE 13: The patient had scoliosis and an enlarged head due to congenital hydrocephalus arrested in childhood. For the past year he had suffered from headache and increasing loss of equilibrium. There were cerebellar signs, but no papilledema. The clinical diagnosis was Arnold-Chiari malformation. Ventricular tap disclosed normal pressure but a greatly dilated lateral ventricle. Encephalography revealed no air in the ventricles. The supracallosal sulcus bulged markedly and the pontine cisterns were compressed. The cisterna

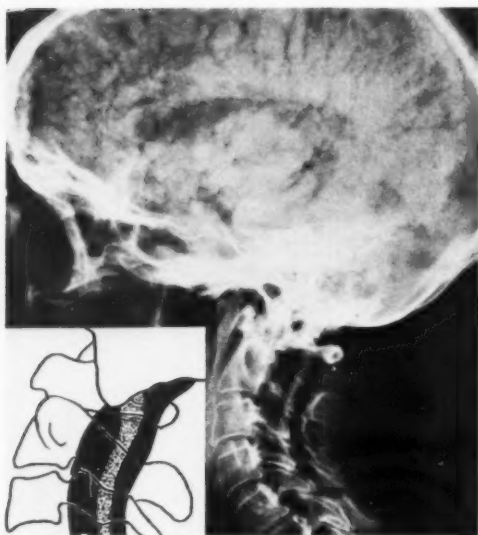


Fig. 9. Case 14. The cystic upper cervical cord, deprived of its surrounding fluid support, collapses in the anteroposterior plane because it is fastened laterally by the dentate ligaments. There are basilar impression and exaggerated cervical lordosis.

magna was unusually small in the anteroposterior diameter, but no filling defect was present. At operation a pronounced thickening of the arachnoid was discovered at the level of the foramen magnum. After this was incised, another membrane, 3 mm. in thickness, was found occluding the foramen of Magendie, representing embryonal atresia of that structure. There was no hindbrain hernia.

CASE 14: The clinical picture indicated a lesion in the upper cervical cord believed to be syringomyelia or neoplasm. Roentgenography disclosed basilar impression with the exaggerated cervical lordosis that usually accompanies this deformity of the skull. Encephalography revealed the narrow shadow of a flattened spinal cord in a distended subarachnoid space (Fig. 9). At operation the exposed upper portion of the cord was found to be a collapsed thin-walled cyst. The cerebellar tonsils were engaged in the foramen magnum, but did not project below it. Fluid aspirated from the cystic cord resembled cerebrospinal fluid. The diagnosis was syringomyelia.

In this case, although the clinical picture and the basilar impression combined to make the diagnosis of syringomyelia fairly certain, the air study eliminated all doubt. Pantopaque myelography is seldom diagnostic in this condition.

CASE 15: The patient presented a clinical picture suggesting the possibility of a tumor at the level of

the foramen magnum. Encephalography revealed no air in the ventricles. The subarachnoid system was normal except for an apparent rounded filling defect in the cisterna magna. Suboccipital operation disclosed normal structures. Postoperative review of the films showed that the apparent filling defect actually was the shadow of an ear lobe superimposed on the cisterna magna. This mistaken interpretation, together with the unaccounted-for lack of entry of air into the ventricles, led to an unnecessary operation. The final diagnosis was multiple sclerosis.

SUMMARY

This paper stresses the importance of adequate facilities and proper precautions in the performance of pneumoencephalography, particularly in suspected cases of tumor. In one year (1956), 306 pneumoencephalograms were made, of which 15 were followed by surgical exposure of the posterior fossa. Although only 2 of the 15 patients had papilledema, a surgical lesion was disclosed in 14. In 10 of these 14 cases, the air shadow in the cisterna magna either made the diagnosis or aided materially in arriving at it. Five of the patients had tumors in the posterior fossa, 1 had a spontaneous cerebellar hematoma, and 1 a meningioma at the foramen magnum. Seven patients proved to have varying expressions of embryonal atresia of the fourth ventricle. In 1 case, misinterpretation of the air shadow in the cisterna magna led to an unnecessary operation.

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SUMMARIO IN INTERLINGUA

Le Importantia Del Umbra Aeree Del Cisterna Magne In Le Diagnose Encephalographic

Le presente articulo sublinea le importantia de un adequate equipamento e del appropriate mesuras de precaution in le technica pneumoencephalographic, specialmente in casos suspecte de tumor. In le curso de un anno (1956), 306 pneumoencephalogrammas esseva effectuate, incluse 15 que esseva sequite per le exposition chirurgic del fossa posterior. Ben que solamente 2 del 15 patientes habeva papilledema, un lesion chirurgic esseva constatate in 14. In 10 de iste 14 casos, le umbra

aeree in le cisterna magne determinava le diagnose o al minus esseva de adjuta significative in determinar lo. Cinque del patientes habeva tumores in le fossa posterior, 1 habeva un spontanee hematoma cerebellar, e 1 habeva un meningioma al foramine magne. In 7 patientes, varie expressiones de atresia embryonal del quarte ventriculo esseva constatate. In 1 caso, le interpretation erronee del umbra aeree in le cisterna magne resultava in un operation innecessari.



Contrast Visualization of Lymph Nodes¹

NORMAN ZHEUTLIN, M.D.², and EDWARD SHANBROM, M.D.

IN AN ATTEMPT to evaluate the relative merits of early extensive radiotherapy of localized lymphoma, it occurred to us that it would be desirable to classify with greater accuracy those cases which could truly be called "localized." This problem seemed particularly important when the inguinal and femoral areas were believed to be the only sites involved, since there was no good method for delineating enlarged pelvic and lumbar lymph nodes. Bruun and Engeset, in an article entitled "Lymphadenography" (1), described the results of injecting contrast material directly into an enlarged lymph node. Modifying their technic, we carried out a series of experiments to visualize lymph nodes and lymph channels. After a trial of various radiopaque media, a method was devised which successfully outlined chains of lymph nodes.

MATERIALS AND METHODS³

The skin overlying an accessible lymph node was carefully cleansed with alcohol. As in venipuncture, the injection of the radiopaque material was carried out without premedication or anesthesia. Once the needle was in place, the patient experienced little or no discomfort. Five cubic centimeters of appropriate iodized oil was drawn into a 5-c.c. Luer-Lok syringe through a clean, sterile 20-gauge needle. With the lymph node firmly held between the thumb and forefinger, the needle was introduced directly into the center of the node. Although several varieties of contrast media were used in the initial studies, it was soon found that water-soluble preparations were undesirable because they were readily absorbed and did not produce opacification. Thorotrast was reasonably

successful but proved to be inferior to iodized oil. Lipiodol afforded satisfactory visualization, but further studies showed that a less viscous material was easier to use. The most suitable agent for these studies proved to be Ethiodol (purified iodized ethyl ester of poppyseed oil, each cubic centimeter of which contains 37 per cent by weight of iodine).

It was found that the prior injection of hyaluronidase (spreading factor) not only enhanced the ease with which an injection could be carried out but facilitated the spread of the contrast substance to adjacent lymph nodes; 75-150 TRU (turbidity-reducing units) were injected with a separate syringe. This syringe was then detached while the needle was left in place and a syringe containing the iodized oil was attached to the same needle. The Ethiodol was slowly injected, at the rate of approximately 1 c.c. per five-minute interval. During this procedure, repeated fluoroscopic observations were made and spot-films were taken (Fig. 1). Upon completion of the procedure, routine radiographs were made at fifteen-minute intervals. At the present time, radiographs are taken at the completion of the injection and followed up in one or two hours. A repeat film is made twenty-four hours later. For this series, further films were obtained at monthly intervals, in order to evaluate results and determine the fate of the contrast material. The total amount of contrast medium injected ranged between 2 and 8 c.c., depending on the size of the lymph node, ease of injection, and spread of contrast. This method differs from that of other investigators, who inject contrast media directly into lymphatic channels.

¹ From the Department of Radiology and Medicine, City of Hope Medical Center, Duarte, Calif. Presented at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17-22, 1957.

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³ The Ethiodol used in these studies was generously supplied by E. Fougere & Co., Inc. The hyaluronidase (Wydase) was furnished through the courtesy of Wyeth Laboratories.

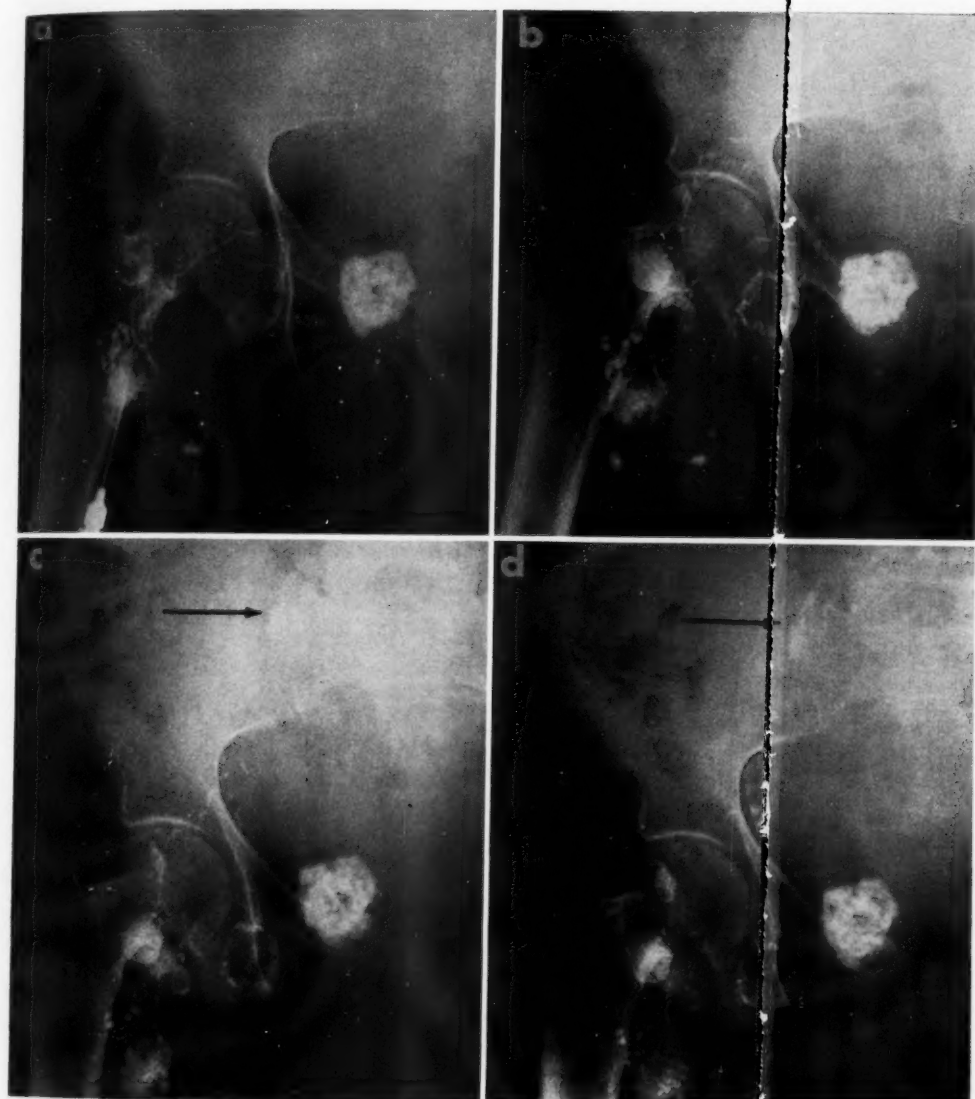


Fig. 1. Seventy-seven-year-old white female with a diagnosis of lymphosarcoma. Serial films, at fifteen-minute intervals, show the sequence of filling following injection of an inguinal lymph node.

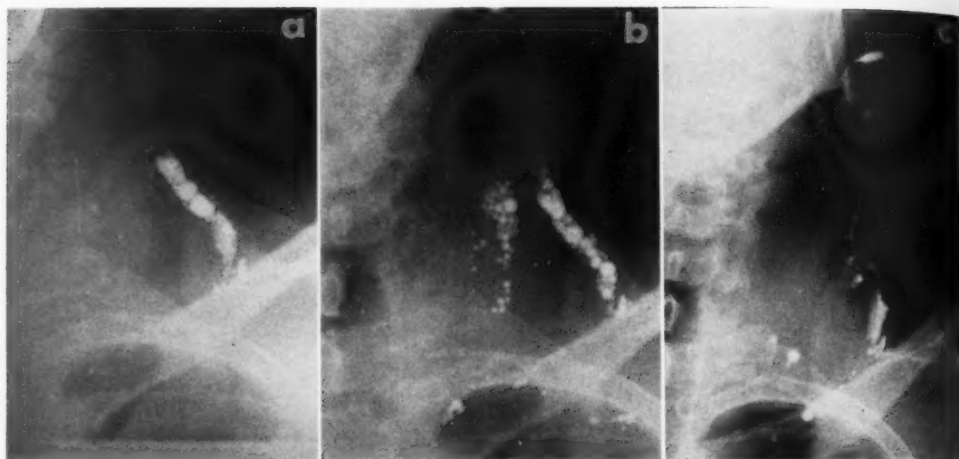


Fig. 2. Thirty-one-year-old male with Hodgkin's disease. Roentgenograms demonstrate the passage of the medium into the venous system from an injected lymph node. The globules of contrast material are in the veins. The irregular linear channels represent the lymphatics.

RESULTS

Lymphadenography appears to be a simple and safe method for visualization of enlarged lymph nodes. Thirty-five separate injections were carried out in 20 patients. There was no discomfort to the patient and there have been no complications in this series. Although we had anticipated the possibility of fat embolism, which could result from introduction of oily substances into the blood stream, no such occurrence was encountered, in spite of the fact that we were able to view the passage of iodized oil directly into the blood stream under fluoroscopy (Fig. 2). While our technic is similar to that of Bruun and Engeset, we have been able to obtain successful visualization of enlarged lymph nodes more frequently, especially in Hodgkin's disease, by the previous injection of hyaluronidase.

This study was originally designed simply to detect enlarged pelvic or abdominal lymph nodes, but it soon became apparent that the technic of lymphadenography yielded additional information. The original aim was easily achieved and we were able to produce visualization of para-aortic nodes by means of the injection of iodized oil into the inguinal and femoral areas (Fig.

3). Beyond this, the procedure has yielded considerable information concerning the normal course of lymphatic channels. It appears, for example, that there is a direct communication of the axillary nodes with the subclavian vein on that side, as iodized oil could be seen entering the subclavian vessels in several different points along its course (Fig. 4). This confirmed the findings of other investigators (2) that there is considerable variation in the arrangement by which lymphatic trunks drain into subclavian vessels. In similar fashion, injection of the posterior cervical nodes in one case showed multiple lymphatic channels which entered the jugular vein at several points.

The general arrangement of lymphatic channels has been more clearly demonstrated in some of our studies. We have noted that in a patient with considerable adenopathy in one site, an injection of a single node outlined a major lymphatic vessel before the adjacent nodes became filled with the contrast substance (Fig. 5). The manner in which the iodized oil traversed the nodes was of interest. Under fluoroscopy, it could be seen entering the peripheral portion of the node first. With further filling, the central portion became



ization of lymph node chains has been satisfactory, we are now experimenting with other technics in the hope of affording better visualization of lymphatic channels. Preliminary observations suggest that aqueous colloidal suspensions of certain contrast agents may achieve this end. From this work it would seem possible to inject radioactive substances of low intensity into a lymph node and achieve more efficient radiation effects in distal groups of nodes. This is worthy of further investigation.

SUMMARY

1. A procedure for contrast visualization of lymph nodes is described.
2. Injections using this method were carried out in 35 instances in 20 patients without any untoward effects.
3. Thin iodized oil (Ethiodol) was found to be the most suitable agent.



Fig. 3. Forty-seven-year-old male with lymphatic leukemia. Roentgenograms of the lumbar area show the presence of contrast material in the retroperitoneal lymph nodes (a and b). Two months later (c).

opaque and the medium then advanced to the next group of nodes *via* the efferent lymphatics. This confirms the findings of other investigators using Direct Sky Blue (3-5).

Although our present method for visual-

4. Clinically undetectable enlarged nodes have been demonstrated by this method, and information concerning the lymphs.

5. Certain anatomic features of the lymphatics are discussed.

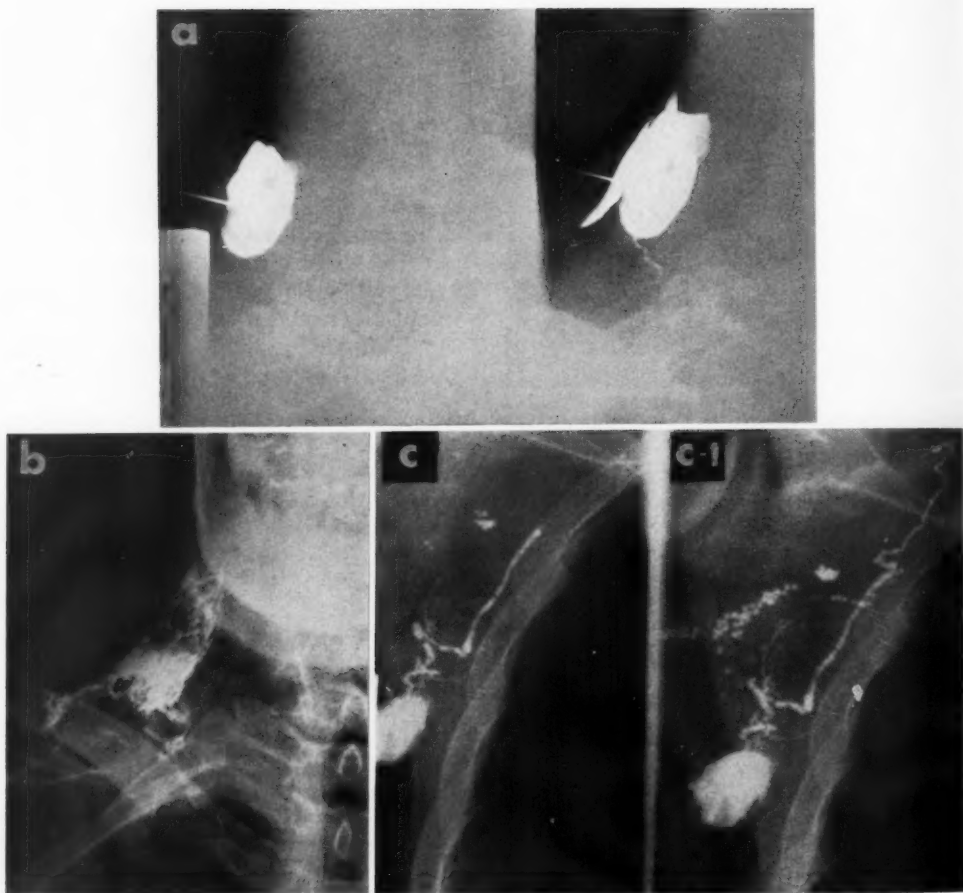


Fig. 4 *a-c*. Forty-five-year-old male with Hodgkin's disease. *a*. Filling of a cervical lymph node with progress into the lymph channels. *b*. Follow-up examination showing contrast material in cervical nodes. *c*. See opposite page.



Fig. 4 c-f. Injection of axillary lymph node with medium entering the subclavian vein (globule formation) and also passing *via* the lymph channels into a cervical node

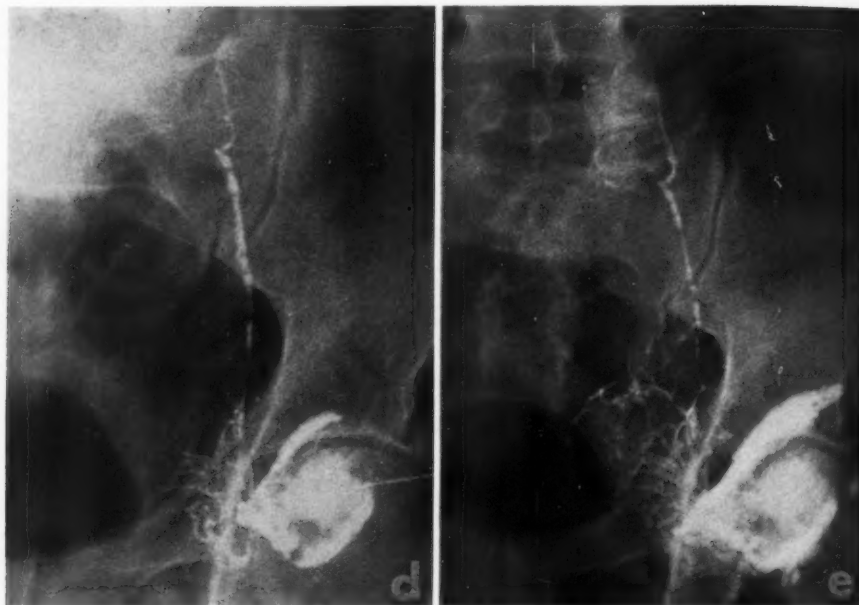


Fig. 5. Same patient as in Fig. 3. Injection of opposite inguinal lymph node demonstrates the contrast material extending into the lumbar area at the same time that the pelvic nodes are being filled.

NOTE. This work was done with the technical assistance of Mr. Stanley Baker.

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SUMMARY IN INTERLINGUA

Le Visualisation De Nodos Lymphatic Per Medio De Substantia De Contrasto

Es describe un methodo pro le visualisation del nodos lymphatic per medio del injection del substantia de contrasto directemente in le nodos. Esseva trovate que le plus appropriate agente pro iste technica es Ethiodol, un purificate e iodisate estere de oleo de papavere, continente—per centimetro cubic—37 pro cento de iodo, basate super le peso. Injectiones anterior de hyaluronidase non solmente facilitava

le manovra del injection del substantia de contrasto, illo etiam promoveva le diffusion de ille substantia in nodos adjacente.

Le methodo esseva utilisate a 35 occasiones in 20 patientes sin ulle effecto adverse. Esseva demonstrate allargamento de nodos lymphatic non detegibile clinicamente. Information con respecto al curso normal del canales lymphatic esseva obtenite.

Studies of Time-Dose Relationships: The Effect of Fractionation¹

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A RECENT REVIEW of the literature on time-dose relationships (1) suggested the possibility of improving the results of radiation therapy in certain circumstances by optimum timing of the individual treatments in a series. This particular aspect of the time factor is based on the theory that there are radiosensitive and radioresistant periods during the overall time of treatment, occurring as a result of temporary arrest of mitosis by irradiation. Since cells are most sensitive during mitosis, this period of arrest is a radioresistant period and radiation given during this time would be relatively ineffective; if irradiation were delayed until resumption of mitosis, it would fall into a radiosensitive period and produce a correspondingly greater effect.

This theory was explored by Koller and Smithers (3) in a clinical experiment in which they took serial biopsies of six skin carcinomas during the treatment course and adjusted their treatment accordingly; that is, if they found no or few cells in mitosis they delayed treatment, but if they found many cells in mitosis they gave a treatment. In this way they were able to obtain good results with lower doses than they had used with daily treatment. Since this procedure is not practical in routine radiotherapy, it was decided to test the possibility of finding a predetermined fractionation plan which would fit a sufficient number of tumor-bearing individuals so that a better response for the group as a whole would be obtained. This had been tried for three types of tumors by Sambrook and co-workers (9) and it was their impression that responses differed, but with only 9 patients definite conclusions were difficult.

The tumor chosen for this study is the

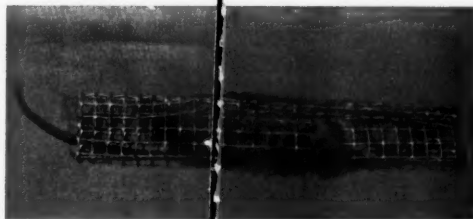


Fig. 1. Method of immobilizing the mouse in wire mesh for treatment.

spontaneous mammary adenocarcinoma of C3H mice. The mice were obtained from the Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine, and later, when it was unable to supply sufficient numbers, from the Cumberland View Farms in Tennessee. No differences were observed between the two groups. The mice were kept in stainless steel cages containing cedar shavings. They were fed Purina Laboratory Chow and had free access to water at all times. They were usually kept about ten days after arrival to become accustomed to their new environment before treatment was begun, but in a few instances mice with larger tumors were treated four days after arrival.

In order to minimize "cage effects" (8), equal numbers of mice from groups being compared were kept in the same cage. An attempt was made to have the tumors of as nearly the same size as possible. The mice were identified by cage number, location of tumor, and sometimes by clipping the hair from one leg. Treatment plans were assigned by selecting a mouse, shuffling the record cards, and choosing a card at random.

Several means of immobilizing the mice for treatment were tried and a method was devised which proved practical. Quarter-inch wire mesh was cut into sheets of

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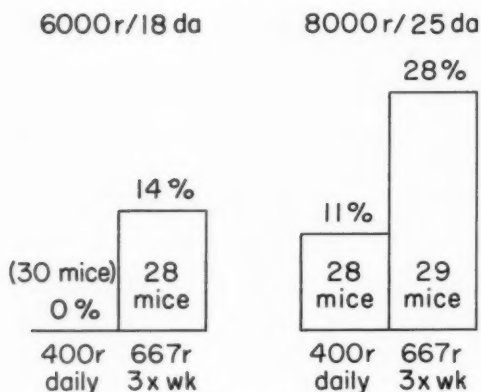


Fig. 2. Tumor response for two fractionation plans with total dose and overall time the same, at two total dose levels. $P = 0.0039$ (ΣX test of Cochran).

appropriate size to enfold a mouse, a hole for the tumor was cut, and the sheet was wrapped around the mouse, leaving the tumor protruding from the hole (Fig. 1). At times, bringing a leg through the opening and taping it with Scotch tape to the outside of the wire was found to be helpful in immobilization. The hair over the tumor was clipped to aid in localization. The field was most often 22 mm. in diameter (to allow adequate margin around the usual 13-mm. diameter tumor), and the mouse was supported by a paper carton. Because of the difficulty of accurate tissue dose measurements under these conditions, and since this study involves only relative doses, air doses were used throughout. The dose rate was 450 r/min. (air) at 20 cm., h.v.l. 0.5 mm. Cu. The machine was usually calibrated once a week.

On the first day of treatment the mice were weighed and the tumor measured by fitting it to a series of graduated openings in a card. Weight, tumor size, and reactions, together with any other observations considered pertinent, were recorded at weekly intervals thereafter until the death of the animal, except that no attempt was made to measure the tumor during the acute reaction, in order to avoid trauma. Originally, it was intended to evaluate all results at six weeks after

the completion of treatment, but because of high mortality among the mice it was necessary to modify this plan and use varying follow-up periods. Every attempt was made to minimize trauma by gentle handling and adequate whole-body protection. Sufficient lead shielding around the tumor was used so that transmitted radiation, as measured by a Victoreen pocket dosimeter, was only 0.1 per cent of the useful beam. The tumor was irradiated tangentially. These precautions, together with the fact that mice handled most often (those treated daily) showed slightly lower mortality than those handled less often (three times a week), make it seem unlikely that either handling or whole-body irradiation could explain the high death rate. A few deaths were due to additional tumors, either coexistent at the time of treatment or developing later, which sometimes killed the mouse even when the treated tumor was controlled. The animals were housed in temporary animal quarters, where conditions were not ideal and this, combined with the lessened resistance to infection resulting from irradiation, may explain the high mortality.

The original plan for the experiment was to give a dose of radiation, perform biopsy at intervals thereafter, count the number of cells in mitosis, and thus determine the optimum timing. When this did not prove feasible, it was necessary to resort to arbitrary treatment plans. In order to eliminate the influence of other aspects of the time-dose relationship, all mice being compared received the same total dose in the same overall time, but with different fractionation plans, that is, with different intervals between the individual treatments in the series and, consequently, with individual doses of different size.

The value of a fractionation plan is assessed by the proportion of mice showing disappearance of tumor as determined by palpation at the end of the follow-up period. Thirty-nine mice in which the result was uncertain were not included in these determinations. A range of in-

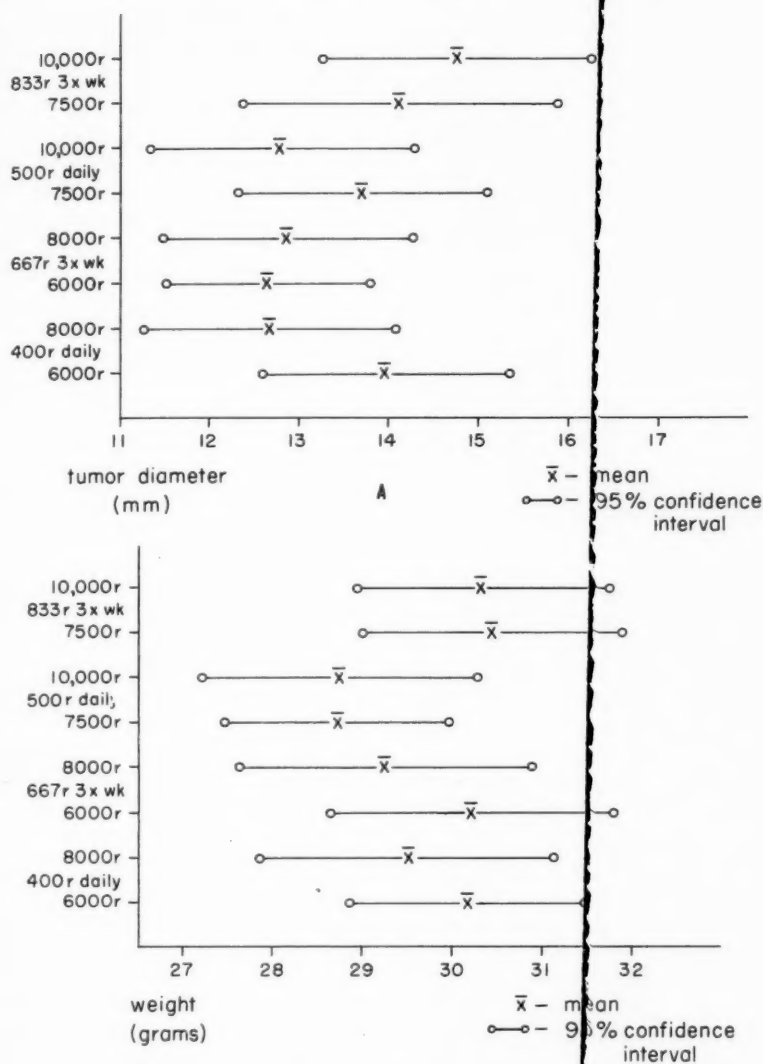


Fig 3. Comparison of material for the different fractionation plans. A. Ninety-five per cent confidence limits for tumor diameters. B. Ninety-five per cent confidence limits for initial weights.

dividual doses from 200 to 5,000 r and of total doses from 4,000 to 12,000 r was covered. A short trial showed that attempts to compare 2,000 r given on five successive days with 5,000 r given on the first and last day (a total of 10,000 r in four days for each technic) would fail, because almost no mice lived long enough for adequate evaluation of the effect of treatment,

and this plan was dropped. Most of the work, then, was done with times of eighteen or twenty-five days (three or four weeks).

As the data accumulated, it was observed that for the same total dose in the same overall time mice treated at the rate of 667 r three times a week showed better tumor response than those treated with 400 r daily (five days a week). Treatment

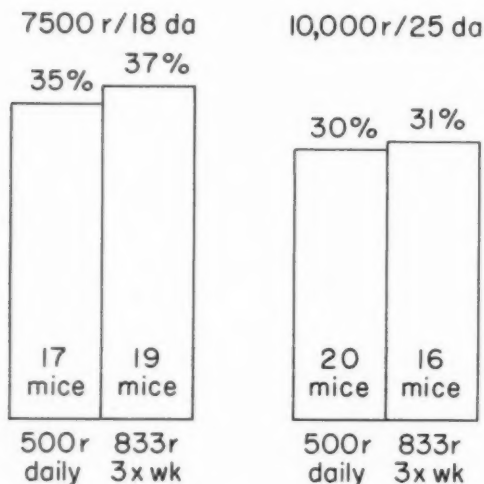


Fig. 4. Tumor response for higher doses and the same timing of treatment as shown in Figure 2. $P = 0.448$.

was limited to five days of the week to conform to common clinical practice, since a difference demonstrated under these conditions would be of more practical importance and should be even more marked if treatments were actually given seven days a week. This improved response was found in both the eighteen-day group and the twenty-five-day group, the corresponding total doses being 6,000 and 8,000 r. The results are shown in Figure 2.

On the basis of the theory outlined, these results would be explained as due to the radiosensitive phase of greater mitotic activity in which the tumor cells were found at forty-eight-hour intervals after doses of 667 r, as compared to the radio-resistant phase of arrest of mitosis in which tumor cells were found at twenty-four-hour intervals after doses of 400 r.

In order to test the possibility that some cause other than fractionation might account for the difference in results, the distribution of factors known to influence response to radiation was compared for the two groups. Goldfeder (2) has shown that these tumors in old mice require smaller doses for control than in young mice. Our mice were all between eight and ten months of age, and this difference is not great enough to influence results.

Also, it has been demonstrated repeatedly that control of the tumor by radiation is in inverse ratio to its size (4). Although, as was stated earlier, an attempt was made to match tumor sizes in the two groups, the distribution of sizes was compared and found to be essentially the same (Fig. 3, A). The weights of the mice were also the same (Fig. 3, B). Total dose and overall time were the same, as stated, and "cage effects" were minimized as described. It would seem, then, that the difference should be attributed to the fractionation plan.

Individual dose and time interval for better response could be related or timing might be independent of dose. In the next higher dosage group mice received 500 r daily or 833 r three times a week, the results being shown in Figure 4. At this dosage level there is no difference between the two technics. In this case, twenty-four-hour intervals between doses of 500 r and forty-eight-hour intervals between doses of 833 r theoretically both found the cells in arrest of mitosis with, consequently, no difference in tumor response. The efficient interval, then, depends on the size of the dose and should be longer for larger doses.

A technic which gives increased tumor response is of little value if it is paralleled by increased normal tissue effects, and of less than no value if normal tissue effects are increased to a greater degree than tumor response. The systemic effect of treatment on the mice was assessed by weight loss during treatment and number of mice dying before completion of the treatment series. The results for the two groups showing a difference in tumor response are shown in Figure 5. The difference in both instances consistently indicates greater effect for the three-times-a-week technic. This is in agreement with the work of Paterson and associates (6), who found an increase in mortality for irradiation broken into two fractions as compared to many fractions. It is felt, therefore, even though the differences shown here are not statistically significant, that for the same total dose and time there is a

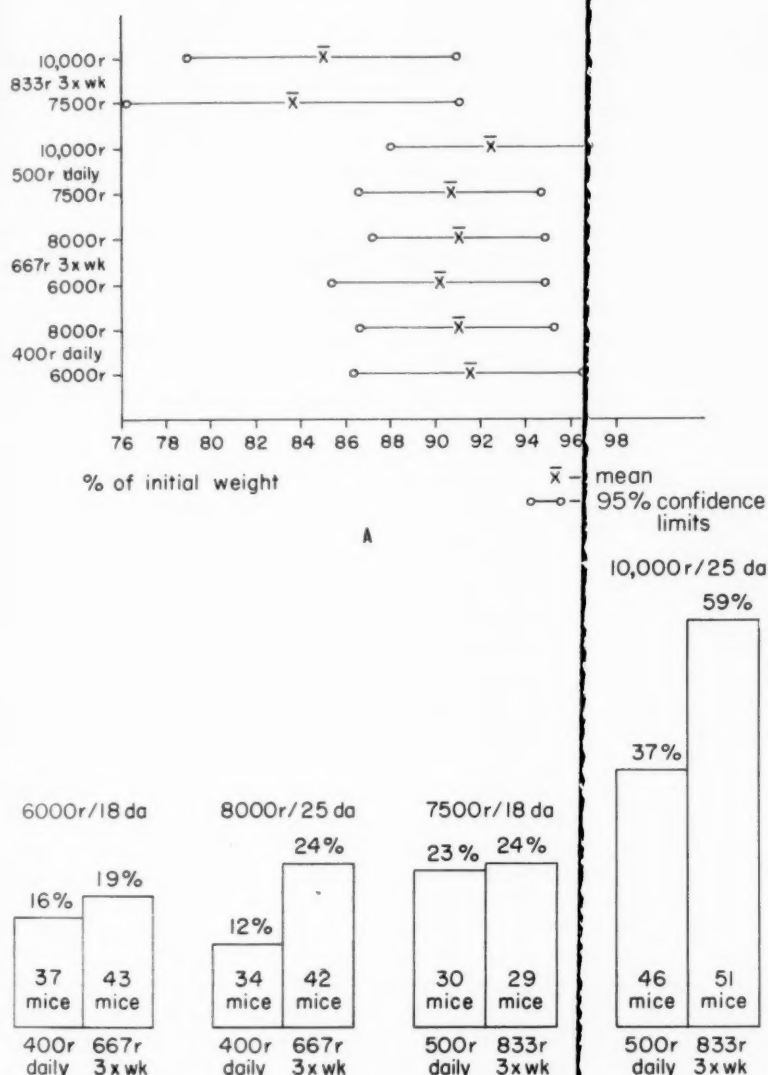


Fig. 5. Systemic effects. A. Ninety-five per cent confidence limits for eighteen-day weights. B. Deaths during treatment.

400 r vs. 667 r pooled across total doses. $P = 0.1251$.

6,000 r vs. 8,000 r pooled across fractionation plans. $P = 0.880$.

500 r vs. 833 r pooled across total doses. $P = 0.0749$.

7,500 r vs. 10,000 r pooled across fractionation plans. $P = 0.0020$.

real, although small, increase in morbidity when the three-times-a-week technic is used. The effect of total dose, however, is very much greater than the effect of fractionation, and it may be that, if the less efficient daily technic were continued

to the dose necessary for the same tumor response, the morbidity would be the same or even greater.

It was difficult to devise an objective evaluation of skin reactions. Subjectively, the moist desquamation appearing as the

early reaction seemed almost identical for the two technics; healing appeared to be parallel, and so few mice lived for a very long time that late effects could not be adequately judged. Here, again, the effect of total dose was much more marked than the effect of change in fractionation. At the least, it seems safe to say that the differences in normal tissue reactions were very much less than the difference in tumor response.

Theoretically, if normal tissue takes longer for resumption of mitotic activity than does the tumor, then it should be possible to find a time when the tumor cells are in mitosis, and hence radiosensitive, but the normal cells are still in arrest of mitosis and hence radioresistant. Spacing the treatments to fall into this period would be optimum timing, since the differential effect in tumor and normal tissue would be increased. Our results substantiate this, since the increase in tumor response with doses of 667 r three times a week over that with doses of 400 r daily was very much greater than the increase in normal tissue reactions.

This method would not be expected to improve results when normal tissue is recovering faster than tumor, as in the case of squamous-cell carcinoma and skin. Here the result would be a greater increase in skin reaction than in tumor control. Protraction of overall time, with treatments given before recovery is complete, takes advantage of the differential recovery rate to achieve a favorable result.

In view of the evidence presented here, together with that of other investigators, that dose response may be altered by degree of fractionation, it should not be assumed that clinical time-dose lines based on daily treatment will necessarily hold for other types of fractionation. A complete description of treatment should contain information on all three points—total dose, overall time, and fractionation.

There is another point of interest in the data shown in Figure 4. In spite of continuing treatment for another week, results were not better, but worse, in those

mice given 10,000 r in twenty-five days than in those in which treatment was stopped at 7,500 r in eighteen days. This cannot be explained by a difference in material in the two groups, since tumor size and weights of the mice were the same (Fig. 3). It is, then, additional evidence of the supralethal effect which has been shown in some clinical studies (5, 7). Examination of the systemic effects (Fig. 5) shows a sharp increase in the twenty-five-day group. This suggests the possibility that supralethal effect may be related to impairment of host resistance.

SUMMARY

Spontaneous mammary adenocarcinomas in C3H mice irradiated at the rate of 2,000 r/week were found to show greater response when treated three times a week than when treated on five successive days. This is true at both the 6,000 r and 8,000 r total dose level. Normal tissue reactions were only slightly increased. An increased differential effect in tumor and normal tissue, therefore, can be obtained by this timing of treatments. The optimum interval between treatments depends on the size of the individual dose, since no difference was found between the two fractionation technics when the rate of irradiation was 2,500 r/week.

The highest dosage group showed poorer results and greatly increased systemic effects. This suggests the possibility that supralethal effect may be related to impairment of host resistance.

NOTE: The statistical analysis was done by Dr. Richard D. Remington, University of Michigan, School of Public Health.

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SUMMARIO IN INTERLINGUA

Studios Del Relation Tempore-Dosage: Le Effecto De Fractionation

Spontanee adenocarcinomas mammari in muses C3H, irradiate al mesura de 2.000 r per septimana, monstrava plus marcate responsas quando le tractamento esseva administrate tres vices per septimana que quando illo esseva administrate in un serie continue de cinque dies. Isto es ver tanto in le caso de un dosage total de 6.000 r como etiam in le caso de un dosage total de 8.000 r. Le reactiones del histo normal esseva augmentate solo levemente. Per consequente, un effecto differential in tumor e histo normal pote esser obtenite

per iste distribution temporal del tractamentos. Le intervallo optime inter le tractamentos depende del magnitudine del doses individual, proque nulle differentia esseva constatate inter le duo methodos de fractionation quando le mesura de irradiation esseva 2.500 r per septimana.

Le gruppo recipiente le maximo de dosage monstrava resultados minus favorable e grandemente augmentate effectos systemic. Isto suggere le possibilitate que un effecto supraletal es forsan relationate a un mination del resistentia in le hospite.



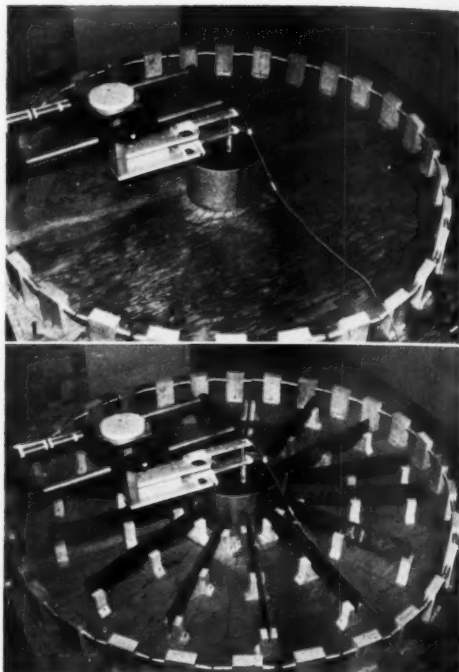
Dose Distribution About Large Circular and Linear Sources of Gamma Radiation¹

I. F. HUMMON, M.D., and ROBERT S. LANDAUER, Ph.D.

THE AVAILABILITY of large quantities of long lived gamma-emitting radioisotopes makes possible the design of radiation sources of various sizes and shapes not restricted to the point sources of x-ray tubes or small quantities of natural radioisotopes. A large ring source could utilize material of low specific activity and holds forth the possibility of achieving doses comparable to rotation or pendulum therapy without the mechanisms usually required.

Cesium 137 is one of these long lived isotopes, having a half-life of thirty years, plus or minus three years. It gives off two beta particles with energies of 0.51 and 1.17 MEV, respectively, and a very useful gamma ray of 0.662 MEV. Large quantities are already available in the fission waste from existing reactors, and much more will be obtainable when the various power reactors begin functioning. Methods have been developed for the separation and concentration of cesium 137, and a plant for this purpose has been completed at Oak Ridge, Tenn.

We obtained from the Medical Division of the Oak Ridge Institute of Nuclear Studies 30 aluminum tubes, 2.5 cm. in diameter and 20 cm. long, each containing a resin upon which had been absorbed approximately 100 μ c. of cesium 137. The maximum difference between tubes was 2 parts in 35, which is less than 6 per cent. The total activity of 3 mc. was considered small enough that protective barriers were not required. These tubes were arranged about the periphery of a circle 2 meters in diameter, and as a 2-meter linear source. Measurements were made of the radiation about these sources by means of an ionization chamber, Geiger-Müller tubes, and small scintillation crystals. The values obtained from



Figs. 1 and 2. Circular gamma radiation source composed of aluminum tubes of cesium 137. Fig. 1 shows a phantom, in the form of a sheet-metal tub, filled with water, at the center of the circle. In Fig. 2 a number of radial lead fins have been added.

all three methods were in good agreement. Most of the data presented here are based upon measurements made with a small Geiger-Müller tube having a volume of 14 c.c. We were primarily interested in total radiation, including scattered radiation, for which the Geiger-Müller tube was satisfactory. Measurements were made both with and without a phantom. The phantom used was a thin sheet-metal tub, oval in shape, with a short axis of 30 cm. and a long axis of 40 cm., filled with water (Fig. 1).

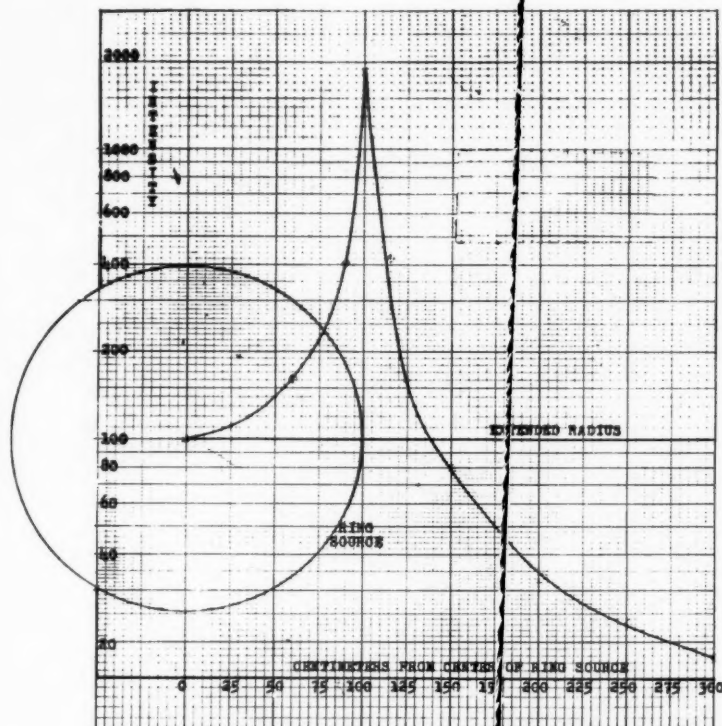
The distribution of radiation about a ring 2 meters in diameter without a phan-

¹ From Cook County Hospital, Chicago, Ill. Presented at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17-22, 1957.

tom or other absorbing material is fairly even in the middle third of the ring, rises sharply as one approaches the periphery containing the source material, and then decreases rapidly (Graph 1).

Measurements were made using various numbers of radial lead fins for the purpose

is present without fins, its periphery receives about 18 per cent more than its center (Graph 3). The relationship of the intensity at the periphery of the phantom to that at the center varies with the number of fins. The use of 5 fins would reduce the surface intensity to that of the center,



Graph 1. Distribution of radiation along one extended radius. No phantom; no fins; no barriers.

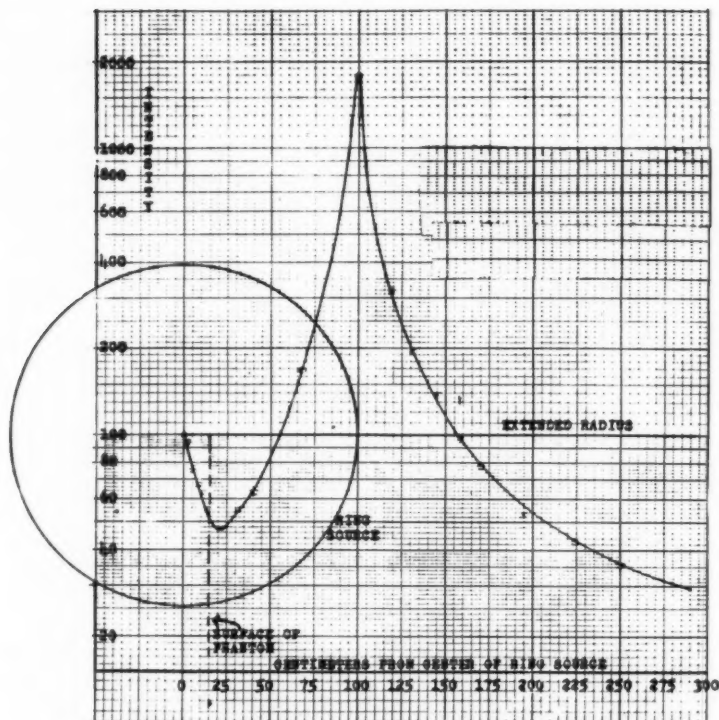
of collimation, each 60 cm. long by 10 cm. wide and about 6 mm. thick. With 15 such fins, the radiation intensity at the center is twice that at the periphery of the phantom. With 30 fins, the intensity at the center of the phantom is three times that at the periphery. The intensity close to the source is similar to that without fins (Fig. 2; Graph 2).

A detailed study of the distribution of radiation close to the center of the ring shows that it is practically uniform out to about 20 cm. from the center when no fins or phantom are present. When a phantom

thus giving uniform radiation throughout the phantom. Increasing the number of fins reduces the surface intensity and also decreases the diameter of the cylinder at the center of the phantom which sees all parts of the source and within which the radiation is fairly uniform (Graph 4).

The linear source consisted of 10 tubes placed end to end, making a total length of 200 cm. The basic data, adjusted to an intensity of 100 at 100 cm. distance along a line normal to the midpoint of the 200-cm. source, is given in Table I.

Graph 5 shows a series of isodose curves



Graph 2. Distribution of radiation along one extended radius, with elliptical water phantom (30 × 40 cm.) and fifteen radial lead fins (10 × 60 × 0.6 cm.).

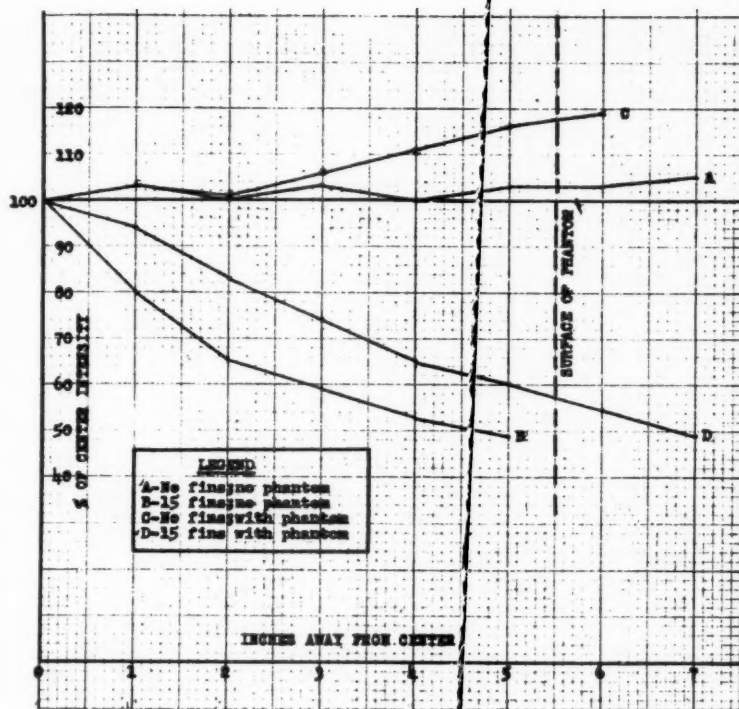
TABLE I: RELATIVE INTENSITIES AT VARIOUS DISTANCES ALONG AND FROM A 200-CM. LINEAR SOURCE

Distance from Axis (cm.)	Center	Distance Along Axis (cm.)							
		20	40	60	80	90	100	110	120
2.5	5,750	5,700	5,650	5,650	5,650	5,465	5,280	3,070	1,375
5.0	3,110	3,075	3,040	3,040	2,900	2,710	2,520		
10.0	1,725	1,717	1,710	1,700	1,630	1,507	1,384		
20.0	800	782	765	750	690	640	600		
40.0	338	338	338	337	288	270	252		
60.0	202	202	202	198	181	169	157		
80.0	135	134	134	134	119	110	101		
100	100	98	96	91.4	84.5	80	75		
120	72.5								
150	52.3								
200	34.4								
250	25								

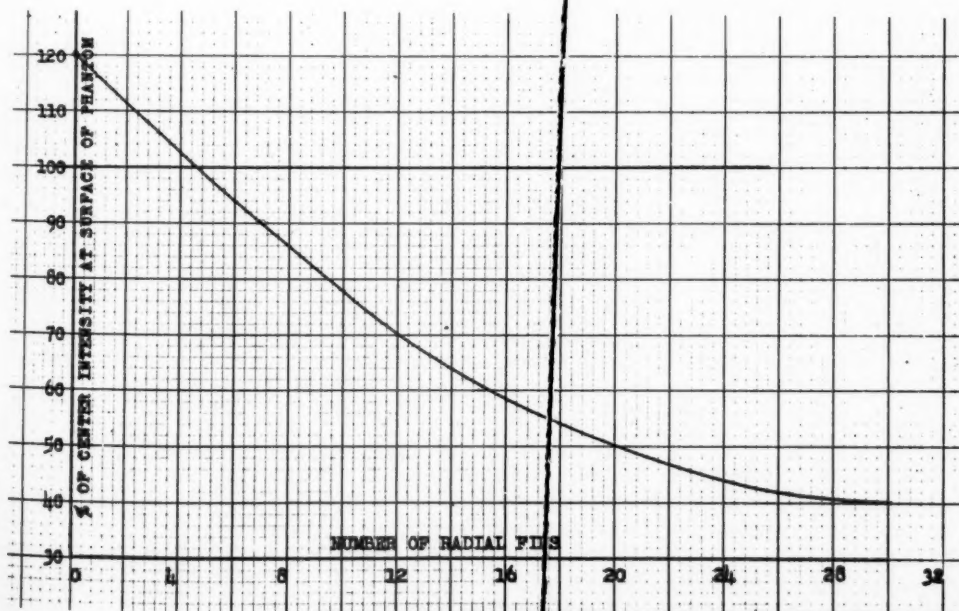
in one quadrant of the 200-cm. linear cesium-137 source. The uniform dose rate along the source at short distances from it was to be expected, as were the sloping curves at greater distances.

Graph 6 shows the relation between radiation intensity and distance from the axis of a linear source along a line normal

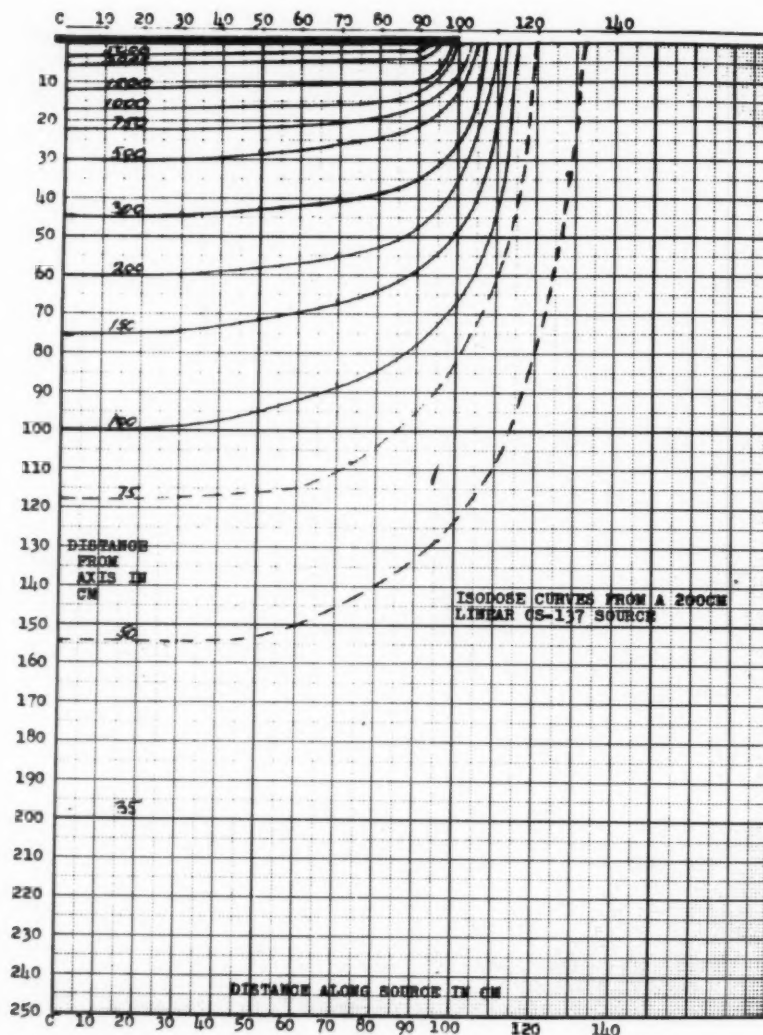
to the midpoint of the source taken from our data. This curve may provide an answer to the question so frequently asked regarding the intensity of radiation from radium needles and tubes at distances less than the minimum of 0.5 cm. given by both Quimby and Paterson-Parker. If the radiation about linear sources were



Graph 3. Distribution of radiation within 6 inches of center of source.



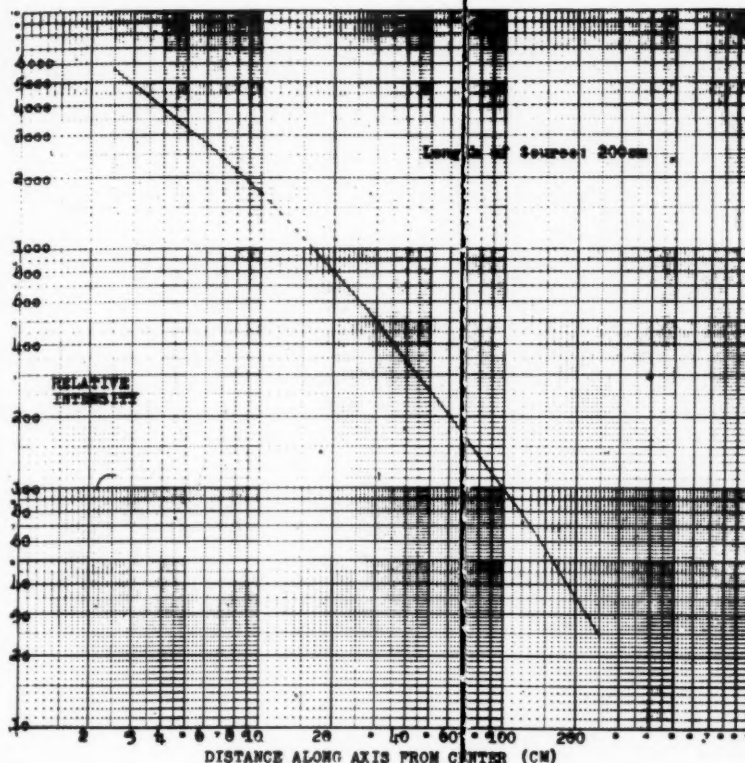
Graph 4. Relation between depth dose and number of radial fins.



Graph 5. Isodose curves from a 200-cm. linear cesium-137 source.

found to follow a certain pattern with sources of different lengths, our data could then be interpolated into data for other source lengths. One such pattern is the ratio between radiation intensities at distances from the source proportionate to the source length, such as the ratio between the intensities at one-fourth and one-half the source lengths normal to the center of the source axis. This ratio is 2.8 for source lengths of 2, 4, and 6 cm. according to Paterson-Parker and for 2 and 4 cm. linear

sources according to Quimby. Our value for the same ratio, namely the ratio between the dose rate at 100 cm. and 50 cm. for the 200-cm. linear source is 2.7. Other ratios show the same agreement between our data and those of Quimby and Paterson-Parker. On the basis of this agreement, the dose rate from a 2-cm. and 4-cm. radium linear source would be as shown in Table II. Data on needles and tubes of other lengths will be presented in the near future.



Graph 6. Relation between dose rate and distance from axis of a linear source, normal to midpoint of source.

TABLE II: DOSE RATES FROM 2-CM. AND 4-CM. RADIUM TUBES

Distance from Axis of 200-cm. Source (cm.)	Ratio to 100 cm. Distance	Intensity Compared to Intensity at 100 cm.	Distance from a 2-cm. Source (cm.)	Dose rate (r/mg.-hr.) from a 2-cm. Source
<i>From a 2-cm. Tube</i>				
2.5	40	5,750	0.025	360
5.0	20	3,110	0.05	195
10	10	1,725	0.1	108
20	5	800	0.2	50
40	2.5	338	0.4	21
50	2	270	0.5	17
60	1.67	202	0.6	12.6
80	1.25	135	0.8	8.46
100	1.0	100	1.0	6.25*
<i>From a 4-cm. Tube</i>				
2.5	40	5,750	0.05	92.7
5.0	20	3,110	0.1	50.3
10	10	1,725	0.2	28.2
20	5	800	0.4	12.9
40	2.5	338	0.8	5.45
50	2.0	270	1.0	4.35*
60	1.67	202	1.2	3.26
80	1.25	135	1.6	2.18
100	1.0	100	2.0	1.61

* Values of 6.25 and 4.35 taken from Quimby.

CONCLUSIONS

The distribution of radiation from circular and linear sources was investigated. From these studies it appears that an extended circular source 2 meters in diameter can be used to obtain uniform radiation throughout a segment of the body. The addition of radial fins of absorbing material makes it possible to reduce the intensity of radiation at the surface of a body in relation to that at the center of the body, thus approximating the results obtained with rotational therapy.

The dose distribution about a linear source is similar for different source lengths provided proportionate distances in relation to the source length are used.

Data for distances as close as 1.25 per cent of source length are presented.

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SUMMARIO IN INTERLINGUA

Distribution De Dosage Circa Grande Fontes Circular E Linear De Radiation Gamma

Le autores construeva circular e linear fontes de radios gamma ex tubos de aluminium (con un diametro de 2,5 e un longor de 20 cm). Cata tubo contineva un resina ad que 100 microcuries de cesium 137 habeva essite adsorbite. Studios del distribution del radiation ab tal fontes resultava in le sequente conclusiones:

Il pare que un extendite fonte circular de un diametro de 2 metros pote esser usate pro obtener un radiation uniforme in omne partes de un segmento del corpore. Le addition de "alettas" radial de un material absorbente rende possibile re-

ducer le intensitate del radiation al superficie de un corpore in relation al intensitate del radiation al centro del mesme corpore, effectuante assi approximativemente le mesme resultados que es obtenite con therapia rotational.

Le distribution de dosage circa un fonte linear es simile pro fontes de differente longores, providite que distantias es usate que es proportional in relation al longor del fonte.

Es presentate datos pro distantias de usque a minimos de solmente 1,25 procento del longor del fonte.



Radiographic Examination of Surgically Removed Specimens with a Radiologic-Pathologic Correlation¹

KIRK R. DEIBERT, M.D.

ROENTGEN study of gross surgical specimens has been found to offer certain advantages under a variety of circumstances. Some of the information that can be obtained in this way will be considered here.

After the superfluous blood and fluid are drained off, the specimen may be placed upon absorbent paper and carried to the department of roentgenology for immediate radiography. The hemostats may be left in place, especially for studies of the intestinal tract. A lead arrow will serve readily to indicate either the oral or caudal end of the specimen. Suitable identification similar to that used in routine roentgen examinations should be incorporated in the radiograph—the date, case number, and indication as to the side, left or right. The specimen, with clean absorbent paper, is placed upon a cassette of suitable size and the exposure is made.

A brief résumé of the technical factors is given in Table I. All examinations should be made on the table top of the radiographic unit, with par-speed intensifying screens in the cassette. The cassette size depends on the size of the specimen; the usual dimensions are $6\frac{1}{2} \times 8\frac{1}{2}$, 8×10 , or 10×12 inches. All exposures are made at 30 inches, with a cone to cover the cassette. The films are developed like any other film, usually for three and a half to four minutes.

The selection of kilovoltage is based upon the usual thickness of the part, on the assumption that moderate collapse and flattening of the specimen will occur. For every additional 1.0 cm. thickness of part 2.0 kv may be added. The only exception to this is Category 4, where an occlusal film may be used. A small calculus or chicken bone does not measure 1 cm. in thickness, but with the reduced milli-

TABLE I: TECHNICAL FACTORS FOR RADIOGRAPHIC EXAMINATION OF OPERATIVE SPECIMENS*

Part	Ma	Time	Kv	Thickness, cm.
1. Small hollow viscus, as appendix, gallbladder; diverticulum	25	$\frac{1}{20}$ sec.	34-36	1-2
2. Remainder of gastrointestinal tract	50	$\frac{1}{20}$ sec.	36	2
3. Solid viscus, as kidney, pancreas, heart; tumor; cyst	50	$\frac{1}{20}$ sec.	40	4
4. Small calculus, fish or chicken bone, tooth	25	$\frac{1}{20}$ sec.	36	1
5. Bone, as segment of rib, vertebra, sternum, ilium	50	$\frac{1}{10}$ sec.	38	2

* The technical assistance of C. B. Crittenden, B.S., R.T., Senior Technician, Eliza Coffee Memorial Hospital, Florence, Ala., is gratefully acknowledged.

ampere-second ratio, increased kilovoltage is needed to obtain a satisfactory image. Since screens are not used in the small film holders employed for this type of exposure, a longer developing time may be needed. With practice, a skilled technician will readily become adept in this procedure.

CARDIAC AND VASCULAR LESIONS

Frequently on acute fluoroscopic scrutiny a calcified plaque may be identified in the pericardium, a vascular orifice, or in one of the cardiac valvular cusps. The aortic and mitral valves are more commonly the site of such deposits, but accurate localization by radiographic or fluoroscopic study is difficult. A black and white photograph will not show to advantage the location of these plaques, but on a radiograph of the specimen they are readily localized as to chamber or vascular stem. Similarly, the identity of a cardiac or aortic aneurysm

¹ Accepted for publication in April 1958.

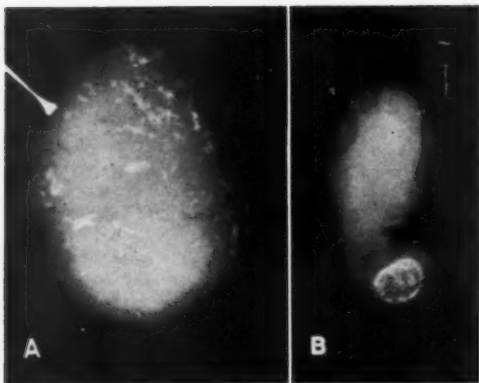


Fig. 1. Roentgenograms of operative specimens. A. Adrenal tumor, nonfunctioning type with calcification (10×8 cm.) causing renal displacement. B. Thick-walled, dilated gallbladder with calculus impacted in the neck.

with or without calcification can definitely be determined. Coronary artery sclerosis is also easily demonstrated.

PULMONARY LESIONS

Verification of partial pulmonary sequestration incident to a broncholith is readily accomplished by a radiograph of a segment of resected lung. The same is true for an hemangiomas vascular anomaly. Preoperative films of primary solid or cystic tumors of the lung or mediastinum may be reduplicated, especially those that are of teratomatous origin or are the site of perimetric calcification.

RENAL AND SUPRARENAL LESIONS

(Figs. 1A and 2)

The kidneys and suprarenals may be the site of solid and cystic tumors displaying calcification. Occasionally, with inadequate preparation for an intravenous pyelographic examination, the localization of small calcific deposits in relation to the calyces or renal parenchyma, as in nephrocalcinosis, may be in doubt. Such a point may be established by obtaining a radiograph of a specimen. By reason of differences in tissue density, fetal renal lobulation, aberrant lobes, and parenchymal cysts are well demonstrated by soft-tissue radiographic technic. Especially is this applicable to tumors of teratomatous

origin, containing admixtures of fat, muscle, connective tissue, and calcium, and to fluid cysts.

GYNECOLOGIC LESIONS

A tuberculous fallopian tube, in addition to being bulbous and cystic, usually contains calcific deposits. An estimate of the stage of development and progression of a nonviable extrauterine pregnancy is readily made, but a degenerated fetus will not be demonstrable. The density of a uterine myoma with satellite nodules is readily outlined on a specimen film, especially if a calcific fibromatous component exists.

LESIONS OF THE GALLBLADDER

(Figs. 1B and 2B)

Not uncommonly, on performance of oral cholecystography, the gallbladder is found to be nonfunctioning and visualization is not obtained. A dilated primary outline of the viscus may, however, be elicited. This can be verified as a hydrops with thick walls by examination of a postoperative specimen. Similarly, the small calcific flecks that are found occasionally upon the mucosa of the gallbladder or in association with cholesterosis are readily visualized. Here a roentgenogram may prove more accurate than a photograph of the gross specimen obtained by the pathologist. Routine pathologic microscopic slides do not demonstrate calcium. This is identified with certainty only by special stains or photospectroscopy.

INTESTINAL LESIONS

The intestinal tract can be studied by several means. The soft-tissue outline of a viscus is discerned with ease. In the pancreas, cysts, calcifications, or tumor masses are easily delineated. A barium suspension may be used to distend and outline the lumen of a segment of colon in contrast to the primary profile showing a neoplastic filling defect (Fig. 3). Lipiodol will outline an internal fistula, or sodium iodide (5 per cent aqueous solution) may be used to demonstrate the outline of a cyst, diverticulum, or intestinal reduplication.

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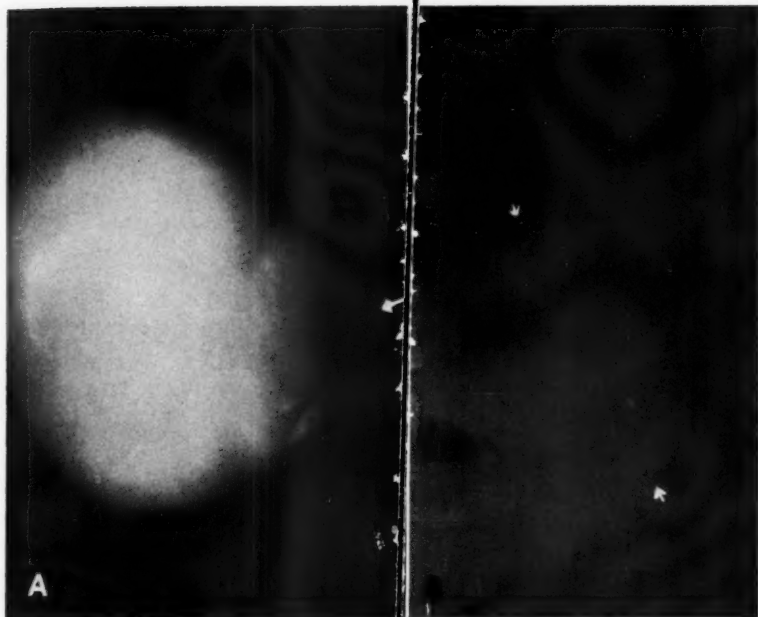


Fig. 2. Case of large right midabdominal mass, mobile on deep inspiration. A. Specimen of large cystic renal tumor. Retained opaque medium in the distorted calyces. B. Scout film of abdomen showing biliary calculi elevated by the mass beneath.

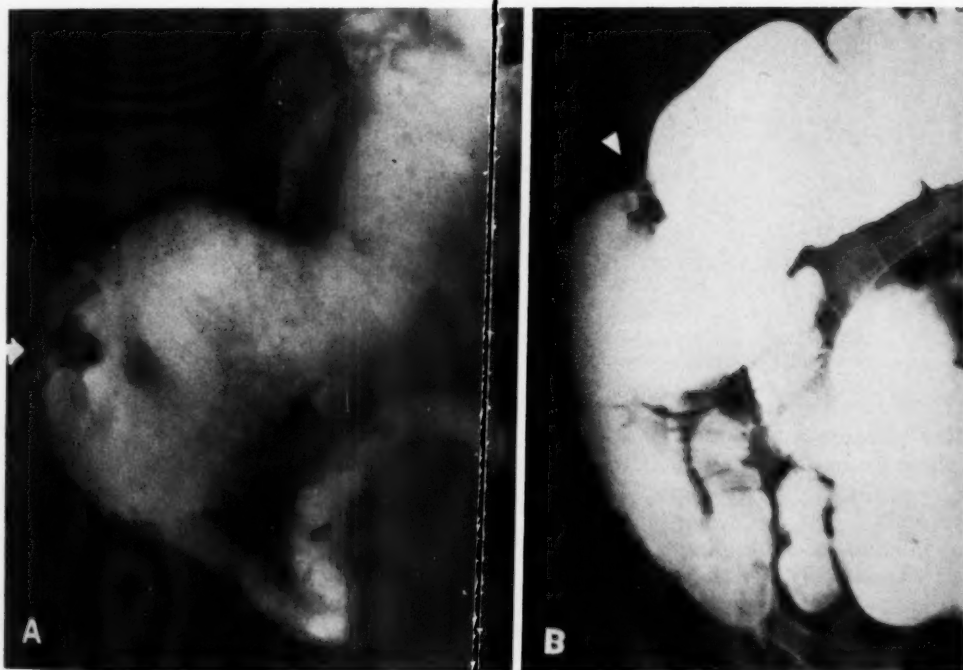


Fig. 3. Carcinoma of the cecum. A. Postoperative specimen filled with a thin barium solution, revealing tumor filling defect. B. Initial contrast enema study. Comparable filling defects indicated by arrows.

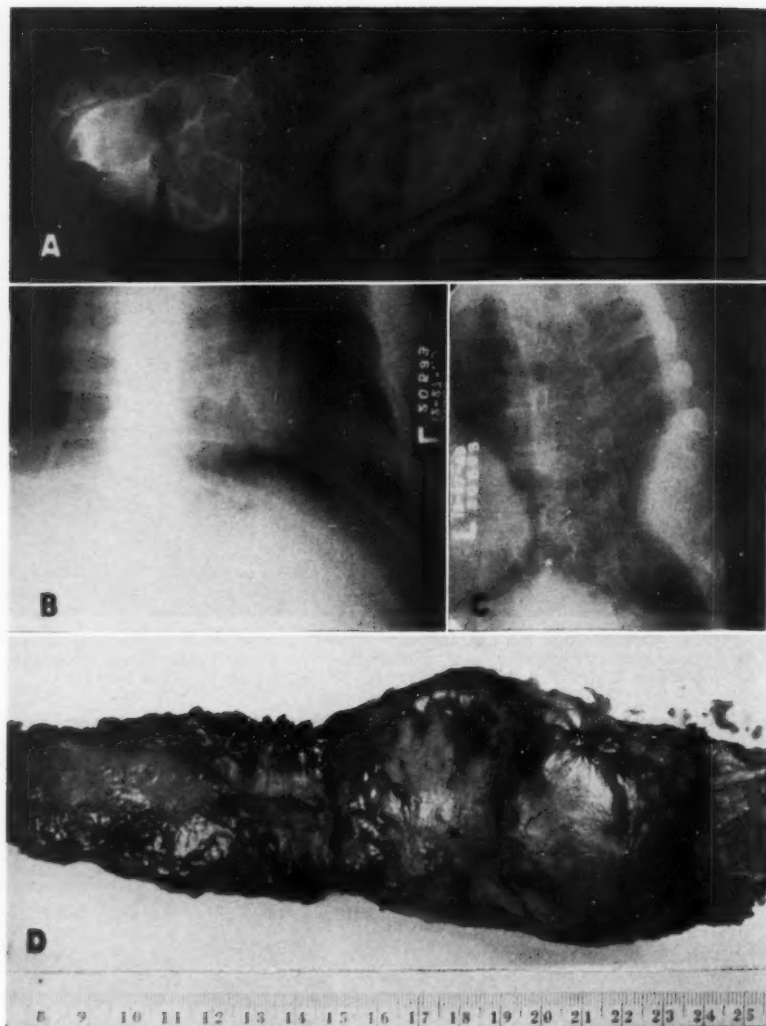


Fig. 4. Fibrous dysplasia, with bizarre lysis of left eighth rib. A. Radiograph of specimen. B and C. Chest films showing lesion. D. Photograph of gross specimen.

(Diodrast could be used similarly as a contrast solution but sodium iodide is cheaper.) These procedures are similar to those employed for routine radiographic studies of patients. Just as the primary outline of a gallbladder containing a calculus casts an excellent roentgenographic image, so delineation of an appendix with a fecalith will verify the presence of a calcareous suppurative appendicitis. A small amount of barium powder or paste applied to the resected specimen will afford a good ap-

preciation of the depth and breadth of a gastric ulcer, corresponding to the crater which is palpable at the time of exploration or the niche which is seen on the initial roentgenogram.

LESIONS OF BONE

Roentgen observations of bone specimens show good correlation with the initial roentgenogram. In fact, they show to better advantage the extent of destruction by a bone tumor and the displacement of

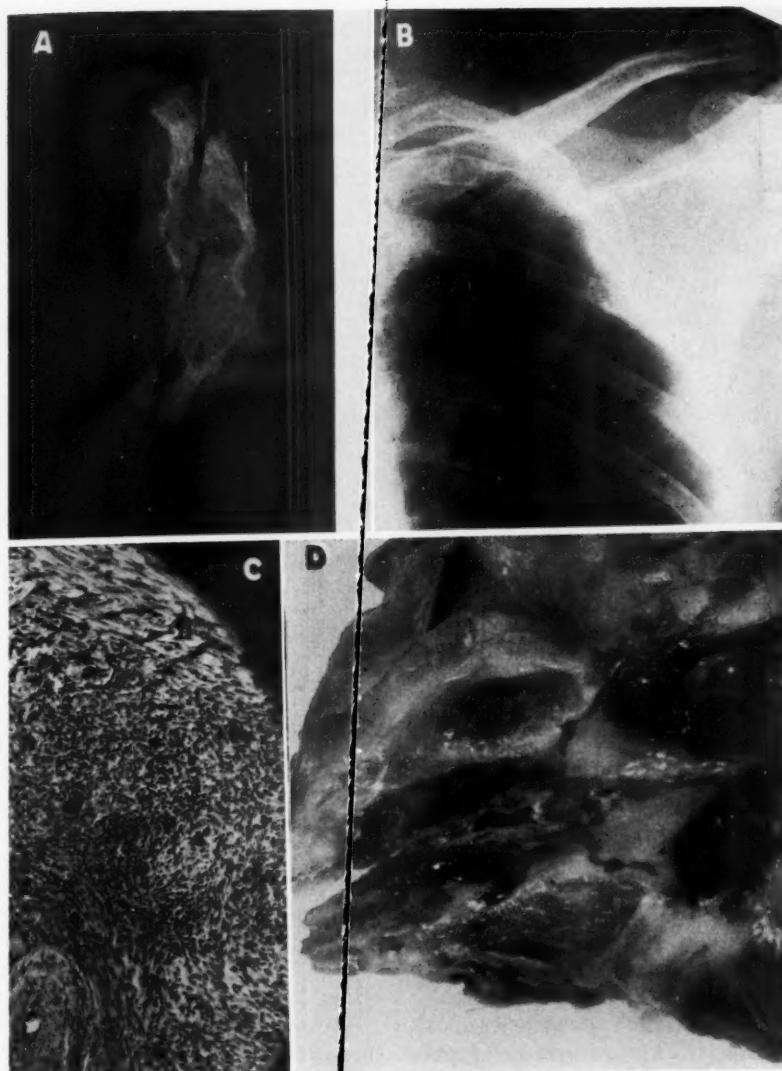


Fig. 5. Rare lytic lesion of rib: benign giant-cell tumor. A. Radiograph of specimen. B. Detail of chest film, showing lysis of left second rib. C. Photomicrograph of lesion. D. Photograph of gross specimen.

the bone matrix of an expanding cystic lesion than does a routine black and white or color photograph. Figure 4 shows, for comparison, the roentgenogram of a large cystic rib lesion of fibrous dysplasia after removal, the posterior-anterior and oblique chest roentgenographs, and a photograph of the gross specimen. In Figure 5 an unusual form of rib lysis is demonstrated, pathologically proved to be due to a benign

giant-cell tumor. The radiograph of the specimen, chest film, photomicrograph, and gross specimen are shown.

MISCELLANEOUS

Occasionally a radiograph of a small object will be of benefit to the surgeon and yield definite information. For example, there frequently exists a discrepancy between the stated size of a ureteral calculus

that is identified by the preliminary intravenous pyelographic study and the calculus or calculi that are retrieved by the urologist at retrograde urologic study or "basket" catheter extraction. An exposure of the calculus with an occlusal film (Category 4, Table I) will suffice to clarify this difference. Similarly, if a small piece of gritty material is expectorated by a person who has a chronic cough, a film may reveal it to contain calcium, identifying it as a broncholith. Repeat chest roentgenograms will also verify this. Not infrequently a calcareous concretion will be found extrinsic to the intestinal tract at the time of an exploratory operation pertinent to the gallbladder, appendix, or a diverticulum. Such a finding may follow perforation of a viscus, be associated with an intra-abdominal fistula, or may actually represent a stone lost at the time the viscus was delivered, in which case a film will prove its recovery. Occasionally a fish bone or a fragment of chicken bone may cause an episode of difficult swallowing. At some later time, the patient may present himself to the surgeon with an "acute abdomen." Preliminary plain films of the abdomen may reveal an ileus. If a radiograph is obtained of the surgical specimen,

the offending fish bone or chicken bone can readily be demonstrated.

SUMMARY

The benefits to be derived from obtaining radiographs of surgical gross specimens have been outlined. Such radiographs will demonstrate intestinal tumors, the extent of invasion and destruction of bone by neoplastic processes, and the scope of fibromatous or dermoid tumor masses. Any mass that contains calcium, either admixed or perimetric, is well suited for this type of examination. An excellent correlation can be established between this type of film and the initial roentgenogram, as well as the findings on exploratory operation.

Frequently radiographs of surgical specimens give information that cannot be obtained by black and white photography. In a small community, if the pathologist cannot take routine photographs of interesting gross specimens, this method may be used as a substitute. The examination may clarify or verify a point in a problematic case for the surgeon and the radiologist.

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SUMMARIO IN INTERLINGUA

Le Examine Radiographic De Specimens Chirurgic, Con Un Correlation Radiologico-Pathologic

Es delineate le beneficios que pote esser derivate ab radiographias de grossier specimens chirurgic. Tal radiographias pote demonstrar tumores intestinal, le grado del invasion e del destruction de osso per processos neoplastic, e le extension de massas tumoral fibromatose o dermoide. Omne massa que contine calcium—admixte o perimetric—es bon pro iste typo de examine. Un grado excellente de correlation pote esser establite inter iste typo de pellicula e le roentgenogramma initial o

etiam le constataciones in le exploration.

Frequentemente radiographias de specimens chirurgic produce informationes que non es obtenibile per medio de photographias superficial. In un micre communitate, si le pathologo non pote facer photographias routinari de interessante specimens grossier, iste methodo pote esser empleate como substituto. Le examine es possibilmente capace a clarificar o a verificar le un o le altere puncto in un caso problematic pro le chirurgo e le radiologo.

Responses of the Developing Fetal Nervous System to Roentgen Irradiation¹

ROBERTS RUGH

THE EMBRYO AND the fetus together represent the most dynamic period in the life of any organism, during which there is a constantly changing mosaic of developmental activity. In addition there is accelerating growth from the relative simplicity of the single-celled zygote to the multimillion-cell organism. Any insult to any part, or to the whole, during this phase may result in abnormalities which cannot be produced at any subsequent period in the life of the organism.

Ionizing radiations constitute a very powerful means of interfering with any biological process, and their effects are more marked and even of different kinds when the embryo or fetus is exposed than in postnatal stages—exaggerated because of the high radiosensitivity during any developmental activity and different because there is interference with organogeny. Developmental abnormalities can be produced only by irradiation during the prenatal stages.

In contrast to the adult organism, there is no uniformity in the reaction of the embryo or fetus from moment to moment, due to the constantly changing structures and dynamic activity. It is therefore impossible to predict, on any quantitative basis, the teratogenic effect of any exposure to ionizing radiations. This unpredictability is not to be confused with normal biological variability, which is probably primarily of genetic origin, but rather to be attributed to other factors peculiar to prenatal development. Nevertheless, certain abnormalities are more likely to occur following even low-level irradiation at specified periods of development; yet it is possible to produce some of the same changes at later stages but only by higher levels of

irradiation. It is probable that low levels of exposure which do not cause teratisms may nevertheless bring about ultimate subtle sequelae detectable only by physiological or psychological tests. If it be assumed from these statements that we do not know the low-level exposure of the embryo and fetus which has *no* effect, that assumption is indeed correct.

The purpose of this paper is to demonstrate that at the morphological level the embryo or fetus as a whole has remarkable powers of resilience and repair, following x-irradiation insult, which can result in an organism topographically quite normal but reduced in size or function.

The nervous system integrates and permeates every part of the organism; from about the twentieth day in the human embryo, and continuously until some weeks after birth, there are embryonic differentiating neuroblasts in increasing abundance, developing from their neurectodermal precursors in association with each of the various organ systems. Neuroblasts are the intermediate stage between the primitive precursor and the ultimate neurone and are now believed to be the most radiosensitive of all cells, rarely surviving an exposure of 40 r. The nature and the extent of radiation damage to the embryo or fetus will be somewhat commensurate with the number and distribution of such radiosensitive neuroblasts present at the moment of irradiation. The ability of the developing organism to reconstitute itself after such an insult will depend somewhat upon the number and distribution of the remaining less sensitive precursors of neuroblasts. Microcephaly, probably the most frequent sequela of fetal irradiation, varies in degree in different individuals,

¹ From the Radiological Research Laboratory, Columbia University, New York, N. Y. Presented at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17-22, 1957, by Dr. Edith H. Quimby, due to the illness of the author.

Based on work performed under Contract AT-30-1-GEN-70 for the U. S. Atomic Energy Commission.

partly in relation to the abundance of undamaged neuroblast precursors. The resilience of the embryo following irradiation may result in a topographically normal but quantitatively reduced organism, particularly deficient in neural elements. To illustrate this fact, we shall concentrate on the neural retina of the mouse embryo, using it to illustrate the neural effects of x-irradiation.

Shortly after optic vesicle formation, the highly radiosensitive neural retina is differentiated. In the rodent there are no cone cells, but the precursors of the rod cells are abundant by twelve and a half days, which corresponds to about thirty-five days for the human. The mouse embryo or fetus can tolerate up to 300 r and be delivered, but the rod cell neuroblasts will be damaged; approximately 50 per cent of the neural retina cells in the mouse exposed to this dose at thirteen and a half days will be destroyed by four hours after the insult. They will be seen as both pyknotic and necrotic; evidently such an insult is an excellent method of locating neural cells in the neuroblast stage.

By twenty-four hours after exposure there is active phagocytosis in the embryo, and by seventy-two hours all of the dead cells and detritus will have been removed by the phagocytes. This means that some 50 per cent of the presumptive neural retina is destroyed and removed and that either this must be replaced by increased growth activity from the undifferentiated and less radiosensitive stem cells, or the ultimate volume of the retina will be reduced. If one determines the volume of the eye of the two-month-old adult mouse, following fetal irradiation to 150 r at twelve and a half days gestation, it will be found to measure only 69 per cent of normal, while if the exposure is to 250 r the reduction will be to 51 per cent. Thus there is also a correlation between the dose of radiation and the loss in eye volume. This is correlated with a reduction in both the rod cell and ganglion cell layers of the retina. These mice are microphthalmic by virtue of the loss of neural cells damaged by x-irradiation dur-

ing the most critical neuroblast stage and the failure of the residual cells to make up the loss by accelerated and increased growth. However, if one examines such eyes histologically, without taking into consideration the volume or the quantitative relationships, the effect of the insult is not apparent. This ability of the developing organism as a whole to reconstitute itself topographically must be clearly distinguished from its inability to replace or regenerate adequately the cells lost through radiation damage. The eye is smaller, and functional, but thus far there has been no way to determine whether there has been any correlated reduction in visual acuity. In like manner, it may be difficult to correlate directly the degree of microcephaly with a reduction in intelligence. It might be mentioned that the reaction just described for the embryo or fetus does not occur in the adult. In fully developed animals there is no such structural loss associated with irradiation.

The word "recovery" is used in radiobiology with several connotations. "Recovery," in the sense that a structurally damaged cell reverts to its prior state, is difficult if not impossible to prove, and probably does not occur. Morphological damage at the cellular level appears to be irrevocable, irreversible, and irreparable. The early embryo simply discards those cells which are damaged beyond use and proceeds to replace them, as best it can, with its remaining undifferentiated and less radiosensitive cells. Thus, the neural retina of the mouse or the presumptive brain of the human, subjected to irradiation insult, will be smaller than normal due to the lack of the normal complement of neural cells. What cells remain may be quite normal with regard to both structure and function, probably dependent on the dose of radiation. This has yet to be investigated. But the integrative forces of the "embryo as a whole" are able to influence the development of the remaining undamaged precursor cells so as to maintain rather normal topography. This implies "organismic" influences in develop-

ment which have been recognized in experimental embryology for many years.

It is probable that the x-irradiation of the embryo or fetus will result in a shortage of neurones in those places which, at the time of the insult, are supplied with neuroblasts in the process of transformation into neurones. Since, of all the tissues, the neural is embryologically the most invasive and widespread, the widespread loss of neuroblasts should be an expected sequence of embryonic or fetal irradiation. Whether the loss will be structurally or functionally demonstrable in the adult will depend both on the stage of development at the time of irradiation and on the dose delivered. It is doubtful that abnormal neurones are produced, and we know that formed neurones can tolerate thousands of roentgens. Since neural teratisms can be formed only by embryonal or fetal irradiation, exposure of the gravid uterus is contraindicated except in rare instances where this is neces-

sary for preservation of the life of the mother.

CONCLUSIONS

While the embryo and the fetus are more radiosensitive than is the adult organism, particularly because of the abundance of highly sensitive neuroblasts, it does have a reserve of undifferentiated and less sensitive precursor cells which, under the control of "organismic" influences, can help to maintain the normal topography of the individual. Following x-irradiation, the resultant organism will be deficient, particularly in neural elements, but the functional consequence of this deficiency will depend on the stage of development and on the degree of insult. Because of these factors, the x-irradiation of the human embryo or fetus should be discouraged, particularly during the first trimester.

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SUMMARY IN INTERLINGUA

Responsas, Del Parte Del Systema Nervose Durante Su Disveloppamento Fetal, Al Effectos de Roentgheno-Irradiation

Durante que le embryon e le feto es plus radiosensibile que le organismo adulte, specialmente a causa del abundantia de sensibilissime neuroblastos, illos possede un reserva de non-differentiate e minus sensibile cellulas precursori, le quales, sub le controlo de influentias "organismic," es capace a contribuir al mantenentia del topographia normal del individuo. Post

roentgeno-irradiation, le resultante organismo es subjecte a varie carentias, specialmente in elementos neural, sed le consequentias functional de isto depende del stadio de disveloppamento e del grado del insulto. A causa de iste factores, le roentgeno-irradiation del embryon o del feto human debe esser discoragiate, specialmente durante le prime trimestre.

Fibrous Stricture of the Stomach Due to Iron (Feosol) Poisoning

Report of a Case and Brief Review of the Literature¹

M. ROBERT WARDEN, M.D.,² GORDON A. MUNRO, M.D.,³ and RAYMOND R. LANIER, Ph.D., M.D.,⁴

IRON POISONING in children has been reported with increasing frequency in recent years. Most of the cases have resulted from accidental ingestion of ferrous sulfate tablets, many of which are of attractive color and taste, which appeal to children.

The acute symptoms of iron poisoning are now well known. They may begin thirty to sixty minutes after ingestion; with less soluble products, damage may be delayed as long as twenty-four hours. The symptoms are vomiting, diarrhea, dehydration, shock, and coma. Severe acidosis has been reported in some cases. Dehydration, shock, and acidosis have resulted in death in about half of the reported cases. The usual treatment includes gastric lavage, cathartics, enemas, intravenous fluids, plasma, and blood.

At autopsy the most striking lesions are

seen in the gastrointestinal tract, consisting in mucosal necrosis, congestion, and focal hemorrhages. Hepatic and renal lesions are also noted. Davis and Gibbs recently reported a case in which a necrotic segment of gastrointestinal mucosa was passed per rectum.

Less familiar than the acute symptoms of iron poisoning mentioned above is the occurrence of fibrous stricture of the pylorus and stomach, occurring as a late complication. Up to the present time, 5 such cases have appeared in the British literature. Crosskey reported in 1952 what he believed was the first case of pyloric stenosis as a complication of ferrous sulfate poisoning to be published in Great Britain. Since that time, Forshall and Rickham have reported 2 cases of pyloric obstruction due to ferrous sulfate, Elliot-Smith and Davies have re-

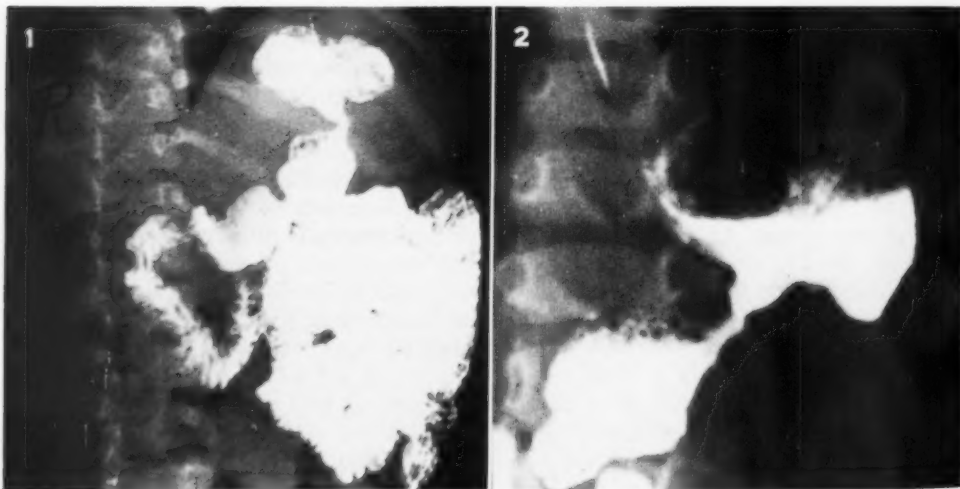


Fig. 1. Stricture of the midportion of the stomach due to iron poisoning six weeks earlier.

Fig. 2. Close-up view of the stricture shown in Fig. 1, demonstrating a possible crater high on the greater curvature side of the defect.

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ported 1 case, and Ross has reported a case of pyloric stenosis and fibrous stricture of the stomach. In the British cases symptoms of gastric or pyloric stricture did not develop until ten days to six weeks after iron ingestion. The patients usually were seen with the complaint of vomiting one to two months after the accident. Four of the 5 did well after operations, which included 2 Mikulicz procedures, 1 posterior gastrojejunostomy, and 1 gastric resection with a Billroth I anastomosis. The fifth patient died as a result of acute peritonitis following a jejunostomy.

REPORT OF CASE

M. M., a two-and-a-half-year-old Negro girl, was admitted to Denver General Hospital on July 23, 1956, following the ingestion of an undetermined number of "Feosol" pills. Her mother found her shortly before admission, after she had vomited some green pills. At the time of admission, the child was semicomatose, arousing herself only for brief periods during gastric lavage (with sodium bicarbonate). She received 250 c.c. of whole blood on admission and was given antibiotics. For the first five days in the hospital she was maintained on fluids administered intravenously. Initially she ran a febrile course with bouts of abdominal distention. An abdominal roentgenogram was compatible with paralytic ileus. Bright red blood was aspirated from the stomach at first, but later stool tests for blood were negative. By the ninth hospital day the fever had subsided and the digestive tract was functioning well. The child was discharged to be followed in the outpatient department.

On Sept. 10, 1956, the patient was readmitted with a history of vomiting beginning two weeks earlier. An upper gastrointestinal series showed marked narrowing of the midportion of the stomach, with some mucosal irregularities particularly along the greater curvature side, which suggested ulcerations (Figs. 1 and 2). The esophagus was normal. A surgical consultation was obtained and, because nutrition was already impaired, an operation was decided upon.

On Sept. 20, the abdomen was opened and the stomach was seen to have a marked hour-glass deformity. The omentum and the extrahepatic ligament were attached to the constricted area. The adhesions were freed, but the narrowing persisted. A Mikulicz type of repair was done with a long incision made longitudinally through the narrowed area. The mucosa was seen to be intact over what appeared to be an old ulcer site, and the stomach wall was greatly thickened. The stomach incision was then closed transversely.

The patient had a good postoperative recovery



Fig. 3. Postoperative result following a Mikulicz procedure.

and functional result. On Oct. 5, 1956, a repeat x-ray study showed slight residual deformity of the midportion of the stomach, with a good flow of barium through the area (Fig. 3). One year later, Oct. 18, 1957, when the patient was seen in the Pediatric Clinic for another complaint, there was no difficulty referable to the stomach.

COMMENT

In two of the reported British cases, histologic sections taken at operation showed superficial ulceration, submucosal fibrosis extending into the muscular coat, and considerable amounts of iron pigment. The mechanism of intestinal ulceration in iron poisoning is thought to be due to the caustic effect of the iron, which produces mucosal necrosis. This destroys the tissue barrier to iron absorption, thus permitting chemically unaltered ferrous sulfate to gain entrance into the veins and lymphatics, causing necrosis and gangrene. It is only after the sugar coating of the ingested tablets dissolves that the caustic action occurs. Thus the esophagus escapes injury and the maximum damage is done to the distal half of the stomach.

SUMMARY

A case of iron (Feosol) poisoning with stricture of the stomach as a late complication is reported. A good operative result was obtained.

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SUMMARIO IN INTERLINGUA

Stricture Fibrose Del Stomacho, Causate Per Invenenamento A Ferro (Ferosol). Reporto De Un Caso, Con Un Breve Revista Del Litteratura

Es reportate un caso de invenenamento a ferro (Ferosol), con stricture del stomacho como complication tardive. Le patiente esseva un puera de duo e medie annos de etate qui habeva inglutite un numero indeterminate de tabletas de Ferosol. Su responsa al tractamento del symptomas acute immediate post le accidente esseva bon, sed circa cinque septimanas plus tarde, vomito se disveloppava, e le

examine roentgenologic revelava un stomacho deformate in "talía de vespa." Isto esseva confirmate al operation. Le reparo esseva effectuate per medio de un operation typico Mikulicz. Le resultado esseva bon.

Cinque casos de stricture fibrose del pyloro e/o del stomacho como complication de invenenamento a ferro esseva trovate in le litteratura britannic.



Two Unusual Manifestations of Advanced Rheumatoid Arthritis¹

THEODORE E. KEATS, M.D.

IT IS THE PURPOSE of this report to describe two unusual manifestations of advanced rheumatoid arthritis which on the roentgenogram may present an appearance sufficiently bizarre to distract the radiologist from an otherwise obvious diagnosis. These manifestations are: first, the formation of endosteal plaques; secondly, unusually profound destruction of articular and subarticular bone. Both entities are seen in the late stages of the disease and are illustrated by the following case reports.

CASE REPORTS

CASE I: E. K., a 29-year-old white woman with advanced rheumatoid arthritis, was admitted to the University of Missouri Medical Center on May 2, 1957, for rehabilitation. The history was one of severe fulminating rheumatoid arthritis with onset at the age of seventeen. Earlier treatment with cortisone had been discontinued after a gastric hemorrhage requiring partial gastrectomy.

Physical examination revealed rheumatoid nodules in the extensor surfaces of the arms and over the tendon of Achilles bilaterally. The motion of fingers and toes was limited, and movement of all joints of the extremities was painful. The spleen was prominent.

Laboratory findings included a normal hemogram, a white blood count of 4,500 to 6,200, a normal urinalysis, protein-bound iodine of 3.3 micrograms, and a negative LE cell test. Free acid was present on gastric analysis. The twenty-four-hour excretion of creatinine was 704 milligrams, which is within the range of normal.

Roentgen examination of the chest, skull, and spine was not remarkable. Examination of the shoulders, elbows, hands, wrists, hips, knees, and ankles showed the usual manifestations of advanced rheumatoid arthritis: increased radiability of bone, marked narrowing of joint spaces, and characteristic deformities of the hands. In addition, the films of the knees, proximal ends of the humeri, and distal ends of the radii revealed eccentrically located dense endosteal plaques of varying sizes. Similar lesions were seen in the hands, in the middle and distal phalanges (Figs. 1-3).



Fig. 1. Case I: Anteroposterior and lateral roentgenograms of the knees showing narrowing of the joint spaces and large endosteal plaques in the distal femoral shafts.

The patient was treated with prednisone and physiotherapy and was discharged improved on May 25, 1957.

¹ From the Department of Radiology, University of Missouri School of Medicine, Columbia, Mo. Accepted for publication in April 1958.



Fig. 2. Case I: Roentgenograms of both shoulders showing narrowing of joint spaces and endosteal plaques in the proximal ends of the humeri.

Fig. 3. Case I: Anteroposterior roentgenogram of the hands showing destructive joint changes, subluxations, and endosteal plaques in the middle and distal phalanges.

CASE II: Films and clinical data for this case were referred to us by Dr. James E. Bauer of Victoria, Texas. The patient was a 51-year-old colored woman who had been in good health until nine years earlier, when she first experienced pain and stiffness in the knees and neck. Three years before the present study she was seen at the University of Texas in Galveston, where her disease was said to have been diagnosed as rheumatoid arthritis. Shortly afterward she noted increasing weakness of her hands and hips and was experiencing some hip pain. Severe deformities of the hands ensued.

Physical examination showed no skin lesions. There was restriction of motion of virtually all of the peripheral joints and pain on movement of the hips. Muscular atrophy associated with her bed-ridden status was evident. Neurological examination was negative.

Laboratory studies showed a white blood count of 8,200, with a normal differential; hemoglobin 10.1 grams per cent; normal urinalysis; negative serologic test for syphilis; serum sodium 14.2 micrograms per liter; phosphorus 3.2 milligrams per cent; calcium 10.2 milligrams per cent; alkaline phosphatase 5.8 Bodansky units. The sedimentation rate was 37 millimeters in an hour.

Roentgen examination of the feet, ankles, knees, and shoulders showed the usual signs of rheumatoid arthritis, with increased radiability of bone and narrowing of the joint spaces. In the feet the commonly seen tapering of the distal ends of the metatarsals and proximal phalanges and indentations in the bases of the proximal phalanges were observed. Subluxations were also evident. Examination of the hips and hands showed destruction of such magnitude that several observers questioned the rheu-

matic etiology. The heads of the femora were completely destroyed, with well defined femoral necks placed deep within acetabula which protruded into the pelvic cavity. The medial walls of the acetabula were thinned (Fig. 4).

The hands showed similar findings. The distal ends of the radii were pointed, with loss of the carpal joint spaces. The distal ends of the metacarpals and the proximal ends of the proximal and middle phalanges were destroyed in an abrupt fashion, similar to that seen in the hip. In addition, there were marked deformities and subluxations (Fig. 5).

DISCUSSION

On the basis of clinical and roentgen criteria there appears to be a little doubt that these 2 cases represent advanced rheumatoid arthritis. The roentgenologic changes other than those under immediate consideration are quite typical and would permit a correct diagnosis with little difficulty.

The pathological changes in the joints in this disease consist essentially of replacement of normal synovial membrane by exuberant vascular granulation tissue which erodes cartilage and invades and destroys bone. Localized cysts or erosions appear near the joint surfaces as a result of such invasion of bone. Eventually the marrow may be completely replaced by fibrotic tissue containing both



Fig. 4. Case II. Roentgenogram of the pelvis showing destruction of the heads of the femora with intrapelvic protrusion of the acetabula.



Fig. 5. Case II. Roentgenogram of the hands showing typical rheumatoid changes in the wrists but with profound destruction and deformities at the more peripheral joints.

lymphoid foci and giant-cell osteoclasts (1). These changes lead ultimately to severe disability with deformity or ankylosis.

The profound destructive changes illustrated in Case II would probably place this patient in the subgroup of rheuma-

toid arthritis described by Schinz (2) as mutilating arthritis, characterized by extensive disturbance of joints and their periarticular tissues and associated with deformities and mutilations. Usually the hands and feet are the sites of predilection. It is difficult to understand why destruc-

tion in these cases progresses so far beyond that which is usually seen. It has been suggested that a trophoneuritic disturbance probably plays a part in the production of the severe mutilations; hence the similarity of these changes to those seen in the so-called trophic disturbances.

Changes of such severity are uncommon but not rare. We have recently seen a patient with rheumatoid arthritis with similar though less widespread changes. Another observer has seen 3 similar cases in another institution (3).

The occurrence of endosteal plaques has been described previously in rheumatoid arthritis (2). Schinz states that occasionally instead of osteoporosis one sees an endosteal increase in bone density. In his experience such endosteal sclerosis attacks especially the middle and end phalanges of the hand. No mention is made of similar involvement of the long bones and no pathologic explanation for this occurrence is offered. We are unable to shed any further light on the histologic significance of these lesions. Their distance from the articular surfaces of the involved bones would suggest that they

are not related to the ingrowth of granulation tissue into the medullary cavity as described above. One might postulate a relationship to a vascular disturbance secondary to the inflammatory process present in the joint. Further elucidation of this problem must await an opportunity for direct histologic examination of the lesions.

SUMMARY

Two unusual manifestations of advanced rheumatoid arthritis are described and illustrated. These are: profound destructive changes of the joints and the formation of endosteal plaques near the involved joints. Such findings should not distract the physician from recognizing the underlying disease.

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SUMMARIO IN INTERLINGUA

Duo Manifestationes Inusual De Avantiata Arthritis Rheumatoide

Es describite du manifestationes inusual de avantiata arthritis rheumatoide. In le roentgenogramma illos pote presentar un apparentia sufficientemente bizarre pro distraher le radiologo ab un alteremente obvie diagnose. Illos es (1) le formation de

placas endostotic in le vicinitate del afficite articulation e (2) le inusualmente profunde destruction de osso articular e subarticular. Ambe iste entitates es vidite in le stadios tardive del morbo.

Es reportate duo casos.

Automatic Long-Segment Serial Angiography: A New Unit¹

JEROME H. SHAPIRO, M.D.², HENRY HAIMOVICI, M.D., F.A.C.S.³,
and HAROLD G. JACOBSON, M.D., F.A.C.R.⁴

ALTHOUGH existing equipment has proved satisfactory for several types of serial angiography covering relatively small areas (cerebral, cardiac, splenic, and aortic), it is increasingly necessary to study longer segments of the vascular system, particularly in the extremities and aorta. The importance of serial roentgenographic examination is now fully accepted. Serial automatic changers covering a small area are available but may require several injections of an opaque medium for study of the entire vascular system of an extremity, with an increased risk to the patient. In some medical centers a variety of manual units have been developed which permit several roentgen exposures of areas up to 14 × 36 inches (1, 2). These long-segment serialographs may provide a satisfactory angiogram with a single injection of contrast material. With the use of manual units, however, there are certain shortcomings: a limited number of exposures, radiation of the physician and technician, and the unreliability inherent in the manual method.

Since accurate delineation of the vascular system has become essential in reconstructive vascular surgery, full-length multifilm visualization is best secured by an automatic long-segment serialograph. A unit of this type has been specifically designed for the Radiology Division of Montefiore Hospital and has been in successful operation for several months.⁵

This serialograph contains six 14 × 36-inch cassettes, which can be serially exposed at predetermined intervals. Conventional sheet film was selected for use in

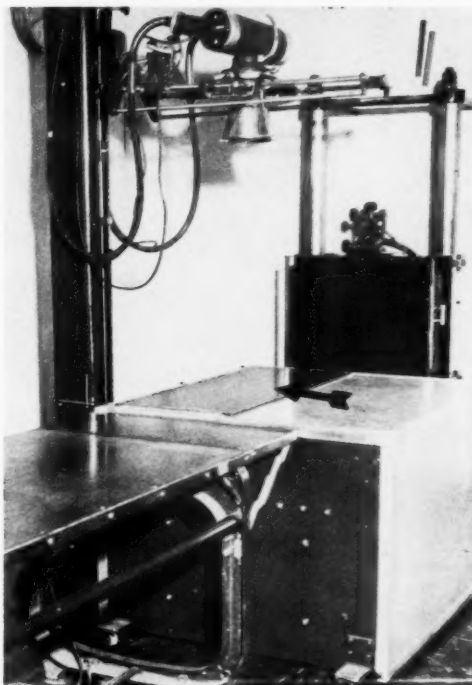


Fig. 1. Photograph of long-segment serialograph in place ready for operation. Arrow points to exposure field (Bakelite surface).

this unit to permit processing with the Eastman Kodak X-Omat. Thus, each cassette contains two 14 × 17-inch films. In order to compensate for the difference in thickness between the proximal and distal portions of the lower extremity, a sheet of paper is used to cover unexposed roentgenograms in the distal half of the cassette. The effect of the intensifying screens is thus reduced by about 50 per cent. A wedge filter may be used in place of the

¹ From the Division of Diagnostic Radiology and the Surgical Division (Peripheral Vascular Service), Montefiore Hospital, New York, N. Y. Accepted for publication in April 1958.

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⁵ Designed by Mr. Ben Rabinowitz of Grafax Corporation of New York City in conjunction with the authors.

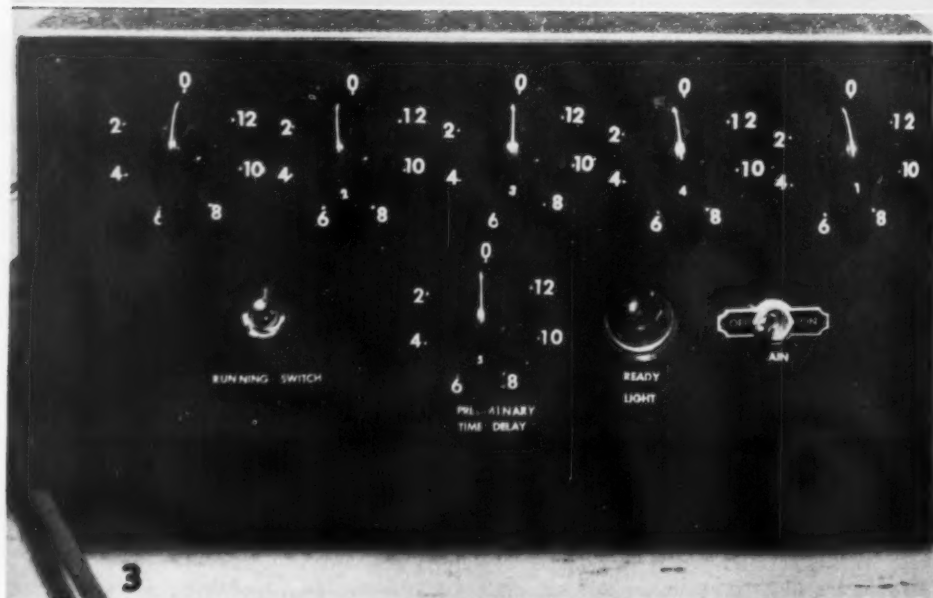
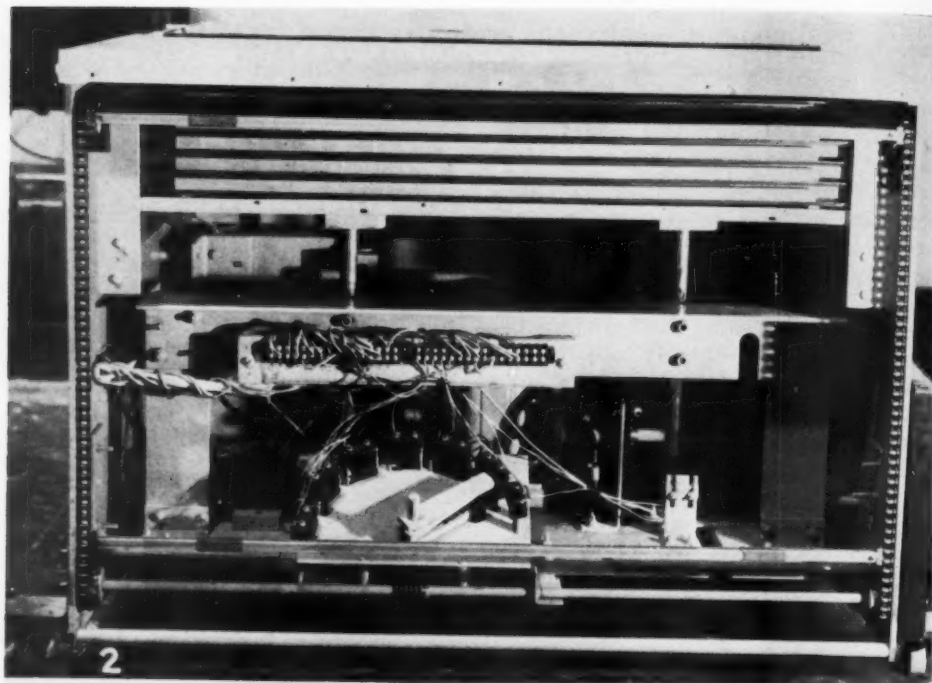


Fig. 2. Side view of long-segment serialograph with cover removed.
Fig. 3. Photograph of interval timer control box fastened on wall in x-ray control area.

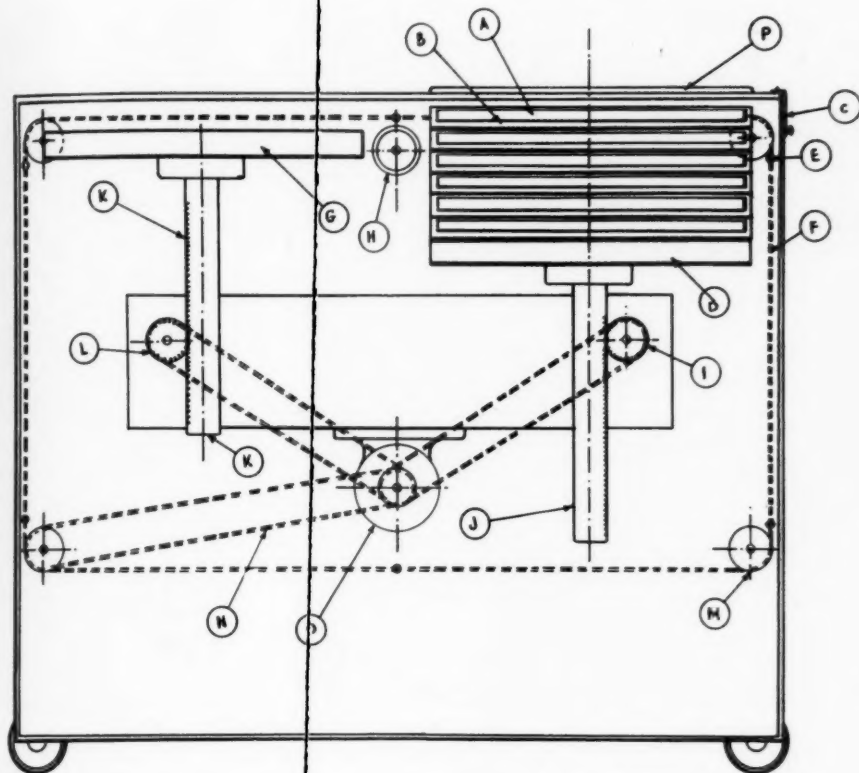


Fig. 4. Cross section of multiple cassette changer with six 14 X 36-inch cassettes loaded on platform "D" under exposure area.

The cassettes are loaded onto platform D through trap door C. The cassettes, A, are stored in tunnels, B, which have lead-lined bases in order to protect the films beneath the one being exposed. The operation is automatically controlled from the master control panel and the apparatus can be pre-set so that films are automatically exposed at two-second intervals and predetermined time delays can be interposed between any exposures.

The motor O drives the elevating platforms G and D through elevating racks and pinions, K, L and J, I, and the transport chain F around sprockets M. The two platforms and transport chain are in continuous motion. Transport rods E, which are connected to the transport chain F, push the top cassette tunnel from its position on platform D onto platform G.

As soon as the cassette is away from the exposure area, the next exposure is made. At this instant platform D is still moving upward and the next rod, E, is still one-quarter second away from making contact with the tunnel and cassette being exposed.

Roller H helps to ease the tunnels onto platform G as they are transported from platform D. This action helps eliminate much of the noise and vibration commonly encountered in mechanisms of this type.

At the end of the sequence the apparatus is set to reverse its direction and redeposit the cassettes in their original position, ready to be removed.

A fixed grid, P, is located on the top panel of the apparatus. The apparatus is 32 inches high, 40 inches long and 39 inches wide. It is mounted on casters and can be readily moved alongside the x-ray table for use.

paper. A fixed grid has been built into the top panel of the unit. The time interval between any two exposures may be set variably from one and a half to twelve seconds.

Photographs of the actual unit (Figs. 1 and 2) and of the interval timer control

box (Fig. 3) are reproduced, and a drawing of the unit in cross section is shown (Fig. 4), with explanatory notes describing its operation.

This automatic long-segment serialograph will produce an accurate visualization of any segment of the vascular system,



Figs. 5-8. Left femoral arteriograms obtained with long-segment serialograph.

Fig. 5. Early phase. An extensive segment of obstruction involving most of the superficial femoral artery is demonstrated. The distal ends of the superficial femoral and popliteal arteries are opacified *via* collateral channels.

Fig. 6. Delayed phase in same patient as Fig. 5.

Fig. 7. Early phase. There is a long segmental occlusion of the superficial femoral artery. A short portion of the popliteal artery is opacified *via* collateral circulation, with an occlusion of the mid portion of the popliteal artery.

Fig. 8. Early phase. A short segmental occlusion of the mid superficial femoral artery is present, with accompanying collateral circulation. Arteriosclerotic changes are present in the opacified portions of the superficial femoral artery.

particularly of the extremities. Occlusive disease can be properly evaluated, including both the segmental lesions and the demonstration of collateral circulation. The interval between serial roentgenograms may be varied according to the flow speed of the circulation. The presence of a variable interval exposure control in the unit permits it to be used in arteriography and/or phlebography. The large cassettes permit the study of an entire extremity. A portion of the chest or abdomen and the proximal portion of an adjacent extremity may be serially examined with a single injection of opaque medium.

Radiation exposure to the x-ray techni-

cian is eliminated. The physician performing the injection is adequately protected with a hanging lead rubber screen. Use of an automatic injection syringe (Gidlund), now available, could thus completely eliminate radiation exposure to the physician.

At the present writing the major use for this unit has been in femoral arteriography (Figs. 5-8), but we have employed it in phlebography, aortography, and lymphangiography. As experience is gained, the unit should prove increasingly effective in the standard angiographic procedures mentioned above, as well as in studies of other types.

SUMMARY AND CONCLUSIONS

A practical, efficient, automatic, long-segment serialograph with variable time-interval control is described. Utilization of this unit in peripheral arteriography, venography, inferior venocavography, aortography, and lymphangiography is indicated. Advantages are discussed.

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SUMMARIO IN INTERLINGUA

Automatic Angiographia Serial A Segmento Longe: Un Nove Apparato

Es describe un practic e efficace automatic serialographo a segmentos longe con regulation del intervallo de tempore. Le apparato produce un visualisation accurate de non importa qual segmento del systema vascular, specialmente in le extremitates. Morbo occlusive pote esser evalutate appropriateamente, incluse lesiones segmental e etiam circulationes collateral. Le grande cassetta (14 X 36 pollices) permette

le studio de un extremitate complete. Un portion del thorace o del abdomine e le portion proximal del extremitate adjacente pote esser examinate serialmente con un sol injection de medio opac.

Usque al tempore presente, le principal usos del apparato ha essite in le arteriographia femoral, sed le autores lo ha usate etiam in phlebographia, aortographia, e lymphangiographia.



Photoscanning After Simple Changes in Present Equipment¹

JAMES C. CARLSON, M.S.

THE UTILITY of photoscanning methods has been established by Bender, Kuhl, Rejali, and others (1-5). In a small hospital it is not always possible to obtain readily the new equipment required for new procedures. Consequently, instrument modifications for the production of photoscans may be of interest to those already possessing a Tracerscanner. Several types of equipment which are used for other studies in the isotope department were combined and modified to produce a photoscanning unit.

The Scanner: Time constants in the count-rate meter and recorder require that the data be obtained with the scan occurring in one direction only. A Tracerscanner was modified as indicated in Figure 1 to produce a slow scan of 1.5 to 4.0 mm. per second and a rapid return of 50 to 178 mm. per second. These changes affect only the return speed. Forward speed, spacing, reset, motion limits, etc., are not affected. The small film density produced during the rapid return of the carriage has not been sufficient to cause concern but, if necessary, an additional relay could be connected in parallel with the solenoid to shut off the light during the return.

The rapid return mechanism, illustrated in Figure 2, consists of a simple spring return which is easily installed as a consequence of the clutch mechanism already contained in the Tracerscanner. In operation, the motor drives the counter support to the back stop bar; instead of reversing the motor, the microswitch operates the solenoid which releases the clutch. The spring tension returns the counter support to the front stop bar, where a small compression spring eases the deceleration of the support system at the front stop bar.

Count-Rate Meter: A Nuclear Chicago count rate meter was modified according

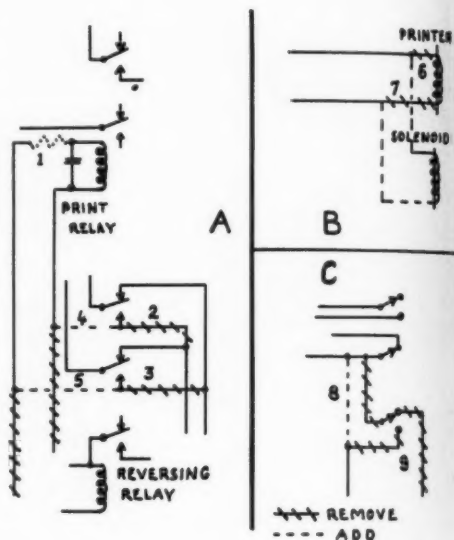


Fig. 1. Tracerscanner model SC-47 circuit modifications. The changes in sections A and B replace motor-reversing action with solenoid operation; those of section C permit spacing movement at only one end of the carriage travel.

Make the following changes at the numbered points: (1) Remove 22K, 2W resistor. Insert a 12K, 2W resistor. (2, 3) Remove these connections. (4, 5) Disconnect at terminals 5A and 6A. Cut off terminal lugs and pull wire back through cabling. Solder to relay connections. (6) Unsolder white-black lead at the terminal which is mounted at the end of the printer support arm. Draw this wire out of its cable. Solder to solenoid. (7) Unsolder blue lead at the same terminal as in No. 6. Wire from 5C to solenoid. (8, 9) Remove microswitch. Connect white and white-black lead to common terminal of rear limit switch. Connect two white-yellow leads together. Cover with tape.

to the diagram of Figure 3 to remove the load resistor, which produces the 10-mv. signal, without disturbing its operation in a normal manner without a recorder, or with a 0-1-ma recorder. In addition, the selection of a one-second time constant was incorporated into the instrument.

Recorder: In place of the usual Esterline Angus or Houston Technical Laboratories chart recorder used in kidney

¹ From the Department of Radiology, Hackley Hospital, Muskegon, Mich. Accepted for publication in April 1958.

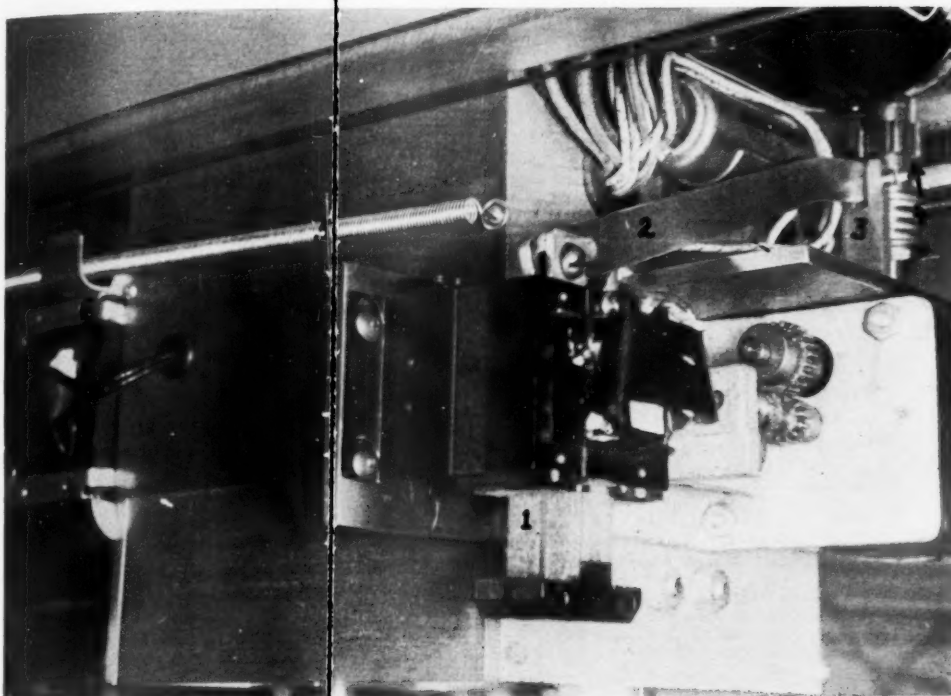


Fig. 2. Photograph showing the parts of the spring return system. When the core of the solenoid (1) raises the lever arm (2), which pivots on the fulcrum (3), the brass-iron clutch mechanism (4) opens, allowing the spring (5) to return the carriage to the front stop bar. The 6.3 V transformer (6) which supplies the filament current is mounted on the carriage.

function studies, a Varian 0.10-mv. recorder may be obtained at nearly the same cost. This equipment was selected because its motor-driven pen has sufficient power to turn the potentiometer, which is a vital part of the light control circuit. A 50-ohm potentiometer was mounted in the chart drive unit and connected to the potentiometer of the servo unit with a slotted shaft. It may be possible to obtain an instrument from the manufacturer with the second potentiometer already mounted in tandem with the servo unit potentiometer, thereby eliminating a mounting problem.

Scintillation Probe: The shielding of a scintillation probe was changed to a focusing collimator by inserting concentric lead cones as shown in Figure 4. The collimation (Fig. 5) which is obtained with the cone approaches that obtained with the honey cone collimator, yet its cost is ap-

proximately 1/20 to 1/100 that of the honey cone type. While this collimator works satisfactorily for thyroid and blood pool studies, it is less than optimum for brain

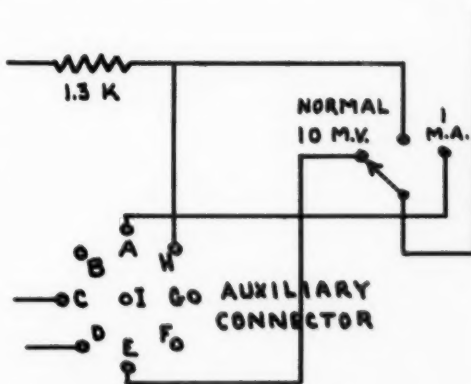


Fig. 3. Nuclear Chicago count rate meter circuit, in which a 10-ohm fixed resistor has been removed and replaced with a 20-ohm variable resistor in an external circuit.

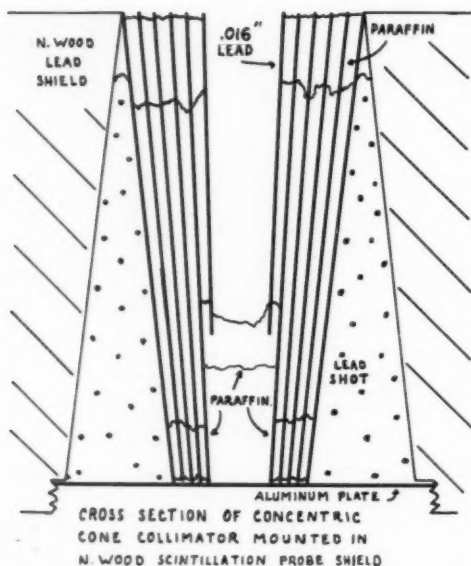


Fig. 4. Concentric cones formed with 0.016 inch lead are held in position with paraffin. Similar cones for other probes contained the lead shot within a lead jacket, making it possible to remove the cones at will.

tumor localization and studies of liver metastases.

Light: Following the schematic drawing of Figure 6, any electronic shop can easily construct the light control, which is similar to Bender's. The utility box containing these parts was mounted directly to the chart drive unit of the Varian recorder (Fig. 7).

After removing the relay parts, a No. 1158 marine light bulb was mounted in a vertical position in the relay housing by soldering its base to the housing (Fig. 7). The bulb was coated with aluminum paint, leaving a small clear area at the tip. A hole drilled through the bottom of the housing and interchangeable limiting diaphragms of thin sheet metal permit the light to fall on the film with a spot (rectangular or square) of the desired size.

High contrast can be obtained by using the large filament, but the current drawn by this filament should readily burn out the 3-turn potentiometer. In practice, more than a hundred hours of use under these conditions has not destroyed the

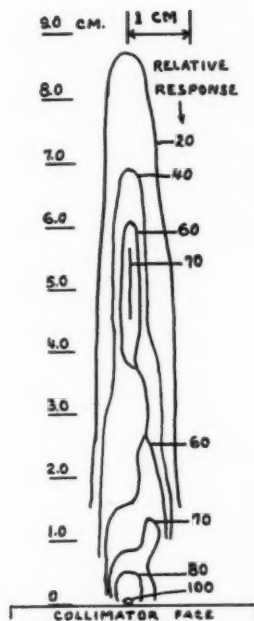


Fig. 5. A misalignment of the cones probably causes the unsymmetrical pattern, but in other respects this pattern approaches that of the honey cone collimators. A desirable attribute of this concentric cone collimator is that it can be constructed by hand with materials costing less than \$2.00.

potentiometer, probably because the conditions of high current are obtained transiently. Most of the studies may be performed with the contrast obtainable with the small filament, and it is recommended that this filament be employed whenever possible.

Film: A film holder was constructed by replacing the Bakelite cover of an old 8 × 10-inch cassette with a 1/8-inch sheet of red transparent plastic. With the red cover and a blue sensitive film (photofluorogram), a thirty-minute exposure to the direct white light coming through the doorway was not sufficient to fog the film.

At the red end of the spectrum, Ansco Triple S Ortho film is two to three times faster than blue sensitive film and, therefore, produces a sufficiently black 100 per

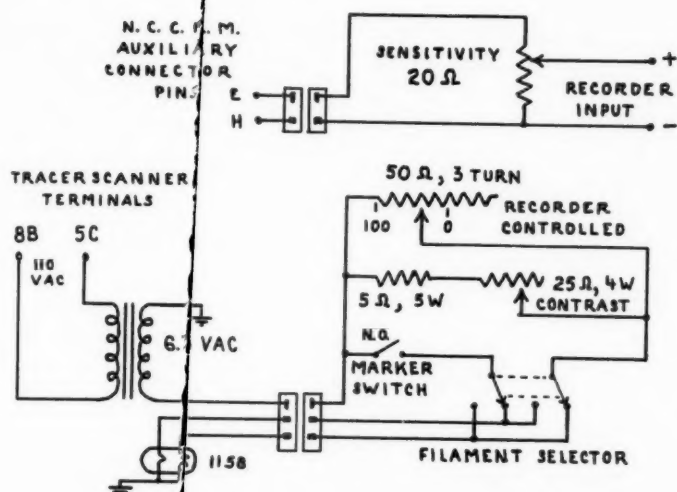


Fig. 6. Schematic drawing of the light-control circuit.

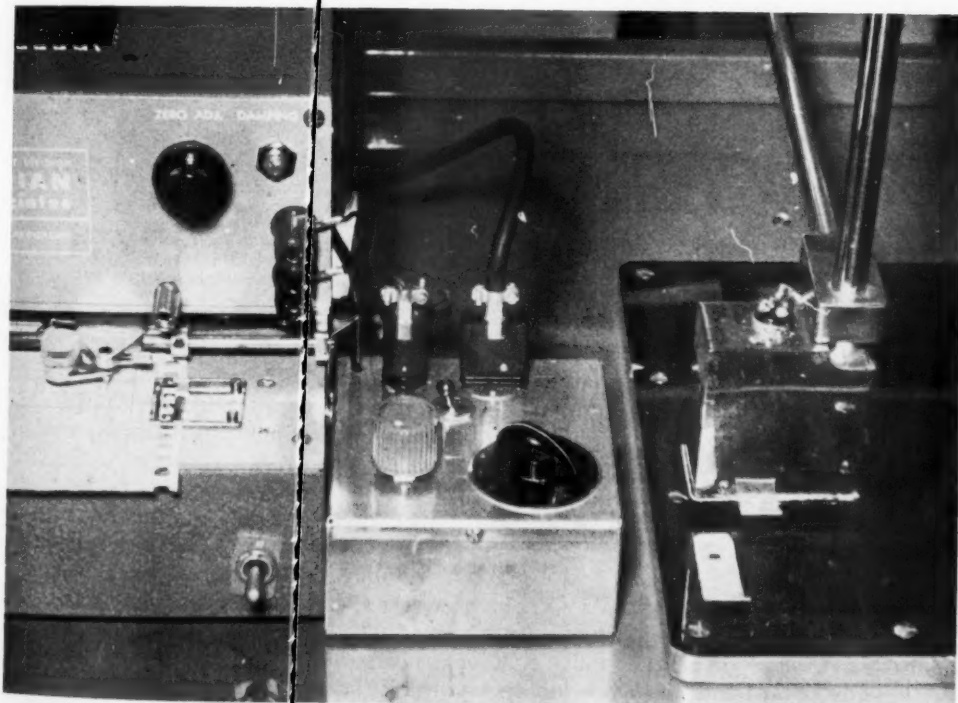


Fig. 7. Photograph of the light-control circuit and light mounting. The light base was soldered to the relay housing in a vertical position. Removable apertures at the bottom of the housing permit the light to shine on the film inside of a cassette placed under the housing.

cent line when scanning at 4.0 mm. / sec. But this film must be handled with caution in the dark room illuminated with light from a Wratten 6B filter because its sensitivity to the orange-red light of the filter is much greater than that of x-ray film. Blue room illumination obtained by covering a view box with blue plastic provided ample light for working and had no effect on the film in the red cassette.

monitor which is connected to an Esterline Angus or Varian recorder. This system could be used instead of the Nuclear Chicago count rate meter. Or a count rate meter designed to fit into the 1000 Scaler may be obtained from the manufacturer.

To obtain optimum results, the operator must be well acquainted with the effects of contrast, sensitivity, scan speed, zero

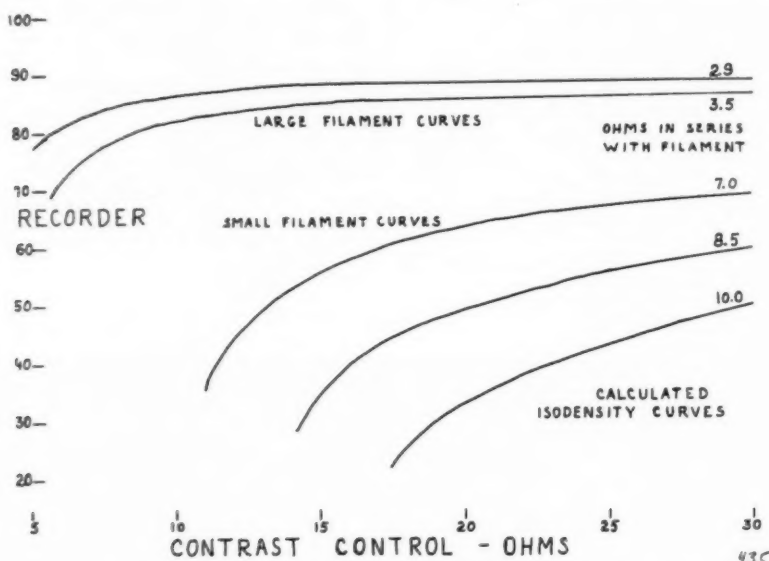


Fig. 8. The recorder value at which the film density is imperceptible varies with the contrast setting, light aperture size, film, and scanning speed. The latter three determine which "ohms-in-series" curve should be used when selecting the contrast setting which will cause a cut-off at the recorder value chosen.

To obtain optimum results, it may be necessary to select a film to match the problem at hand. When low count rates dictate slow scanning speeds, the blue sensitive film will produce a sufficiently dense pattern. At high scanning speeds, best results will be obtained with the Ansco Triple S Ortho film.

DISCUSSION

Obviously, photoscanning equipment can be constructed with other units that may already be at hand; *e.g.*, this laboratory feeds pulses from the 1000 Scaler, which is supplied with the Tracer Scanner, into an old SU-3 Tracerlab laboratory

suppression, aperture size, and film sensitivity on the finished photoscan. Using data from his own unit, he should construct a graph similar to Figure 8 to aid in selecting the proper contrast setting for the problem at hand.

Just preceding the production of the photoscan, several ink-on-paper recordings are obtained in the course of scanning over the area of interest. Examination of these recordings indicates what additional adjustments in zero setting, sensitivity, time constant, and scanning speed are necessary to produce the optimum photoscan, thereby eliminating the need to repeat the procedure.

This system is ideal for brain tumor localization because at maximum contrast an area of activity 5 per cent above or below that of the surrounding areas may be outlined. Yet, this equipment is not limited to brain tumor localization because its large number of adjustable parameters permit it to be used on any problem requiring photoscanning technics.

Parts for these modifications cost approximately \$60, and their specifications may be obtained from the author.

NOTE: The author is indebted to Drs. L. E. Holly, A. H. Joistad, and E. H. Johnson for their support of this project.

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SUMMARY IN INTERLINGUA

Photoscrutinio Per Medio De Un Simple Modification Del Equipamento Existente

Ben que le utilitate del photoscrutinio es un facto establite, le equipamento necessari pro iste technica non es disponibile in omne hospital de micre dimensiones. Le autor describe un methodo de modificar un *Tracerscanner* e facer lo usabile pro le objec-

tivos del photoscrutinio. Plure altere typos de equipamento usate pro altere studios in le departamento de recercas isotop del hospital esseva combinate e modificate in le construction de un satisfacente apparatusa de photoscrutinio.



An Interview with Madame Curie

An Historical Note¹

BENJAMIN H. ORNDOFF, M.D.

FOR AN UNDERSTANDING of the significance of the interview to be presented here, it seems proper first to outline the background against which it took place.

The Board of Chancellors and officers of the American College of Radiology had adopted the rule of holding what was termed an International Conference of the American College of Radiology at each succeeding International Congress of Radiology. When the Third International Congress was being organized for Paris in 1931, it became the writer's duty, as the Executive Secretary, to arrange for the International Conference. This included plans for a dinner or luncheon party, at which Honorary Fellows from foreign countries were guests, the honorary fellowship was conferred upon additional radiologists, citations and gold medal awards were presented, and such other duties carried out as would be appropriate.

While the Third International Congress of Radiology was being organized by Dr. Antoine Bécère, the President, and Dr. Ledoux-Lebard, the Secretary-General, the officers and chancellors of the College decided that the opportune time had arrived for realization of their long cherished dream of honoring the woman who had shared so largely in the founding of the science for which the College was established. After voting unanimously to confer on Madame Marie Curie the Gold Medal of the College, they ordered their Executive Secretary to make the necessary arrangements and to include the award on the program of the International Conference.

It was quite generally known that such honors had already been heaped upon Madame Curie and that she had accepted some of the very notable ones with reluctance—or at least in an unusual manner.

She had, for example, delayed formal acceptance of the Nobel Prize for three years. We knew also of the situation she had created on the occasion of her trip to the United States, which was sponsored by the Federated Women's Clubs of America and national scientific societies. Her itinerary was to be climaxed by a special meeting in beautiful Ryerson Hall of the Art Institute of Chicago. The program arranged included generous gifts and awards that the sponsoring groups had labored to provide. For these the personal appearance of the great scientist before a rather small but select group of American women and scientists would have been considered adequate remuneration. She chose, however, to stay in her hotel suite, just across the boulevard, and delegated one of her aides to represent her. The officers of the clubs and societies were annoyed—and mortified.

With such occurrences in mind, I approached my task in connection with the 1931 Conference with great humility, feeling that my ingenuity was taxed to its utmost.

To facilitate the completion of the objectives required of me, I arranged to be in Paris a little more than one week ahead of the time of the Congress. Having completed—before leaving the United States—the arrangements for the place of the Conference and dinner, which was the Army and Navy Club, I lost no time in securing an interview with Madame Curie at the Institute. It was my good fortune to have known for some years Madame N. Dobrovol'skaia-Zavad'skaia, who not only was associated with Madame Curie in the Institute but was on terms of intimacy—indeed, almost kinship—with her because of their birth in the same Polish city. To

¹ Presented before the Radiological Conference of the Rocky Mountain Radiological Society, Denver, Colo., August 15-17, 1957.

Madame Zavadskaia I am deeply indebted for her courtesy at this time and subsequently, until her death in 1955.

While I had met Madame Curie on several previous occasions, our acquaintance was indeed casual, certainly so far as she was concerned. Largely through the good offices of Madame Zavadskaia, arrangements were made for our first interview at the Institute on the afternoon of Monday, the week preceding the Congress.

Upon arriving at the Institute, I made contact first with Madame Zavadskaia, who conducted me to Madame Curie's room at the corner of the building on the second floor—from the window of which one could see the spot where Pierre Curie had been fatally injured twenty-five years earlier. As we entered the room, there stood our little lady, looking from one of the windows, apparently in a state of meditation. Turning to us, she was greeted by Madame Zavadskaia, and I was presented. I expected, quite naturally, the coolness she had exhibited toward me at our earlier meetings but, to my amazement, she seemed glad to see me, and during our rather brief interview she actually smiled more than once.

Several points which we discussed are still fresh in my memory. I quickly came to the point of telling her that I was there to make the arrangements for presenting her with the greatest honor our College could confer, and that we had hoped that we might complete some details for the occasion. She replied promptly, almost with a smile on her face, and in a very earnest manner. As Madame Zavadskaia interpreted her French to me, it was to the effect that she would be very happy to receive this honor, and that, so far as the arrangements were concerned, she would gladly comply with anything that I would plan.

At another point in the interview, I attempted to convey to her the very high esteem in which she was held by the College officers and chancellors and the sense of indebtedness on the part of all for her pioneer work, which had created an en-

tirely new division in the field of science. Very modestly, she replied that her discoveries were not so important, but that she believed the way was now open for a truly great advance. Considering the significance of her reply in the light of the rapidly expanding knowledge of nuclear fission and radiation, it appears as an approach to divine wisdom.

Returning again to my efforts to consummate our arrangements, it seemed that at this first interview everything that I thought might take many days was settled and completed. During the week, however, I could not avoid sensing a sort of vacuum, without closer contact with the object of our attentions. I decided therefore to arrange an evening dinner at which I proposed to invite the Bécère family, Dr. Ledoux-Lebard, Professor Regaud, Madame Curie, and Madame Zavadskaia. Madame Zavadskaia, however, to whom I confided my plan, was certain that Madame Curie would not attend any function with the others whom I had mentioned. It was finally settled, therefore, with Madame Curie's consent, that she should come to dinner on Saturday evening with Madame Zavadskaia only—and myself—at the Russian Café.

We were to dine at six o'clock. At four o'clock in the afternoon, a message arrived from Madame Zavadskaia, stating that Madame Curie would not come. Remembering again the experiences in Chicago, I could only feel that this indicated that she would not attend any of the other meetings I had arranged. Madame Zavadskaia, however, who did dine with me as per our arrangement, said she was not surprised at the turn affairs had taken, but that Madame Curie had positively stated she would dine with the chancellors at noon on Monday and receive the medal with our ceremonies, as one of us.

On the morning of the day of the dinner, another message reached me, indicating that Madame Curie would not dine with the chancellors but that she would be present at one o'clock on the roof garden of the Army and Navy Club to receive the

medal. It never dawned upon me that she would come without Madame Zavadskaia, who had always acted as our interpreter.

The dinner was served as planned to the chancellors, and I warned them, regardless of completing their meal, to meet promptly at one o'clock in the roof garden. Probably fifteen minutes before that time, I left the group to go to the roof, to determine that everything, including the Pathé sound movie film apparatus, was ready. The spot afforded a beautiful view, overlooking the Place de la Concorde, with the Eiffel Tower but a few blocks away. In another direction, the blue dome of Les Invalides and many other notable historic monuments came within range of vision.

As I moved about, I noticed a lady dressed in dark garb over in one corner of the roof garden. With fear and trembling, I wondered if it could be Madame Curie. I hastened over, and there she was, alone, with a rather pleasant smile for me. Knowing that it would be at least a few moments before our group would arrive, I did my best to keep her interested and if I ever needed to speak the French language, it was then.

Finally, our men began to pour through the door to the roof garden and soon some thirty radiologists, representing the American College of Radiology, with American

radiologists well represented, were assembled and our ceremony started. Doctors Bécère, Forestier, and Ledoux-Lebard were, I believe, the only French physicians present. In Madame Zavadskaia's absence, there was no interpreter and, of course, Madame Curie carried on no conversation with French radiologists. In fact, I believe the only ones to whom she attempted to convey her thoughts were Dr. Albert Soiland and myself. She complied with all our requests while the ceremonies were in progress and, when we asked her to respond, she spoke into the microphone. This, I believe, represents the only film sound record of her voice ever to be made.

A few brief comments may be added in closing. As a result of physical hardships during her days of scientific research, and the death of her husband, Madame Curie came to live more and more aloof from friend and foe, with almost complete indifference to the world's acclaim. Yet, while we saw her in this period of profound depression, there remained evidence of youthful beauty and innate intelligence.

What more fitting tribute could be offered than the words of Einstein, while she was still living: "Marie Curie is, of all celebrated beings, the one whom fame has not corrupted."

401 Talcott Road
Park Ridge, Ill.



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WORK IN PROGRESS

Modification of HeLa Cell Survival by 250-kvp and Cobalt-60 Radiation: Variation with Depth in Tissue-Equivalent Phantom¹

FREDERICK J. BONTY, M.D., JACK S. KROHMER, M.A.,
MURRY W. SCHONFELD, M.D.,
and BETTY ANN WALKER, M.A.

Numerous attempts have been made to evaluate relative biological effectiveness (RBE) of radiation beams of different energies. Biological approaches to this problem have usually consisted in the determination of surface effects on large animals or man, or lethal effects on small animals. In every case the RBE has been measured with little or no attenuation of the radiation beam by overlying tissue or tissue-equivalent material.

were small, they have assumed that there is probably no change in RBE of these radiations with depth.

Since the work of these investigators had never been paralleled in biological terms, an attempt was made to measure the differences in biological effectiveness of beams of 250-kvp and cobalt-60 radiation with changes in depth, in a tissue-equivalent absorber, in terms of survival of cell culture material. HeLa cell parent strain (3) was selected and was handled throughout according to the methods described by Puck *et al.* (4, 5). HeLa cell culture material was irradiated in a phantom constructed as follows: a cubic Lucite box, 1 foot in each dimension, was filled with water and equipped with a Lucite rack which would support four test tubes at measurable depths below the beam entrance surface.

On the basis of pilot experiments, a radiation dose of 500 r was chosen, which has proved to be in the 60

TABLE I: SURVIVAL MEASURED BY ABILITY TO FORM MACROSCOPIC COLONIES AFTER EXPOSURE TO 500 r 250-kvp OR Co⁶⁰ RADIATION AT STATED DEPTH BELOW BEAM ENTRANCE SURFACE OF TISSUE-EQUIVALENT PHANTOM

Depth in Phantom	Cobalt 60		250 kvp	
	Experiment Number	Per Cent Survival	Experiment Number	Per Cent Survival
2 cm.	(1)	38.8 ± 4.4	(1)	32.1 ± 2.1
	(3)	43.6 ± 5.4	(2)	29.0 ± 3.8
	(4)	39.3 ± 2.0	(5)	31.8 ± 2.8
	(6)	38.3 ± 6.7		
		AVE = 40.0 ± 4.9		AVE = 31.0 ± 3.0
5 cm.	(3)	37.2 ± 4.1	(2)	28.9 ± 2.9
	(4)	36.2 ± 2.2	(5)	31.9 ± 3.7
	(6)	29.3 ± 4.0		
		AVE = 34.2 ± 3.6		AVE = 30.4 ± 3.3
8 cm.	(3)	33.7 ± 3.4	(2)	29.6 ± 1.5
	(4)	33.4 ± 1.7	(5)	31.6 ± 2.5
	(6)	31.8 ± 4.5		
		AVE = 33.0 ± 3.4		AVE = 30.6 ± 2.1
10 cm.	(1)	33.8 ± 2.2	(1)	31.6 ± 2.0
	(3)	31.4 ± 3.6	(2)	29.0 ± 3.5
	(4)	29.8 ± 2.0	(5)	32.4 ± 3.6
	(6)	27.7 ± 5.0		
		AVE = 30.7 ± 3.4		AVE = 31.0 ± 3.1

It is known that beams of radiation are degraded in passing through tissue-equivalent material, and it is of interest, therefore, to determine whether there is a variation of biological effectiveness of a given type of radiation with depth in tissue or phantom. It is further known that the more energetic radiations (for example, gamma rays from cobalt 60) are degraded more rapidly than are radiations from lower energy sources (as 250-kvp x-rays). One might then expect to find greater modification of biological effectiveness with depth for cobalt-60 radiation than for 250-kvp radiation. Cormack and Johns (1) and Bruce and Johns (2) approaching this problem from the physical standpoint, have attempted to measure the variation in linear energy transfer (LET) with depth in a tissue phantom for various types of radiation. They have shown a modification in LET with depth for all of the radiations but, because variations

to 70 per cent lethal range at whatever depth tested. This dose was measured within the phantom at all experimental depths under all experimental conditions, by a Bomke instantaneous dosimeter. Measured doses matched best available depth dose data for all radiation sources employed. It should be noted that both under measurement and experimental conditions, no material of other than unit density was present within the radiation beam.

Known numbers (100-250) of HeLa cells were introduced in suspension into plastic test tubes for irradiation within the phantom. Within three hours after irradiation, cell suspensions were transferred for surface growth into glass bottles. Radiation effect was measured in terms of cell survival, the criterion for survival being the ability of the irradiated cell to propagate and form a macroscopic colony containing 50 or more cells within nine days.

Results were expressed in percentage survival, with control material survival set as 100 per cent. Control suspensions and cultures were subjected to all experimental conditions except irradiation.

Table I embodies the results of six experiments in which suspensions of HeLa cells were exposed to measured doses of 500 r of 250-kvp or cobalt-60 radiation at depths of 2, 5, 8, and 10 cm. within the tissue-equivalent phantom. Each result is the mean of two to eight samples. It can be seen that there is no measurable change in the biological effectiveness of 250-kvp radiation within the range of depths tested. Cobalt-60 radiation, on the other hand, shows increased biological effect with increase in depth, as measured in terms of decreasing cell survival. This illustrates the relatively greater degradation of a beam of very high energy with increasing depth, as predicted from theoretical considerations. Further, it is interesting to note that the difference in biological effectiveness between 250-kvp and cobalt-60 radiations, which is present at 2 cm., diminishes with increasing depth, and has apparently disappeared at 10 cm.

Modification of cell culture survival appears to be a valid method for measuring the biological effect of radiation and will be further employed to study effects at surface and in depths greater than 10 cm. for radiations of the above, and additional, qualities. The method also appears to lend itself to the evaluation of other factors which may influence radiation lethality (work in progress).

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¹ From the Department of Radiology, University of Texas Southwestern Medical School, Dallas, Texas. To be presented at the Forty-fourth Annual Meeting of the Radiological Society of North America (Section C), Wednesday, Nov. 19, 1958.

Cineradiography of Calcified Valves¹

MYRON PRINZMETAL, M.D., ELEANOR MILES,
STANLEY WEINER, M.D., and
REXFORD KENAMER, M.D.

The technic of cinerecording the fluoroscopic image and the electrocardiogram simultaneously has been described in a previous report (1). Briefly, this technic consists of recording in slowed motion on 35-mm. film the fluoroscopic image with an optically superimposed electrocardiogram. The Philips roentgen image-intensifier tube² with 5-inch fluoroscopic screen is used in conjunction with the Bell and Howell "Eyemo" 35-mm. camera.

Early in 1957 we began using this method for studying cusp movement of calcified aortic and mitral valves. Location of the calcification is determined under fluoroscopy, and the patient is so manipulated that the best view of the valve is obtained. The anterior right oblique position has been found to furnish the best view of the valves. With the patient positioned, a shield with a 2-inch circular window is slipped into place between patient and fluoroscopic screen, with the window over the valve area. Minor adjustments in the patient's position are then made. With the windowed shield, all areas under fluoroscopy except the valve region are masked, thereby allowing concentration on the valve itself. When direction of movement in relation to other cardiac structures is to be ascertained, the full 5-inch fluoroscopic circle is recorded. The camera speed used for registering valve motion is 55 frames per second.

A 16-mm. reduction print is obtained from the 35-mm. negative, and kinetic analysis is made in two ways. Static analysis is possible by enlarging single selected frames and plotting excursion of the cusps in two directions; continuous motion analysis is made by projecting the strip film with the L-W Industrialist, a 16-mm. stop-motion projector.³ This is a modified Kodascope Analyst and was designed specifically for viewing research films. It is possible to project in either direction at speeds ranging from approximately 5 to 24 frames per second. At the slowest projection speed, there is tolerable flicker and no change in light intensity. An impulse push-button control allows for single-frame operation. The electrocardiogram, superimposed on the film, can be accurately and objectively correlated with valve motion at all phases of the cardiac cycle. The effect of valvulotomy may be studied.

Thus far 8 patients have been examined. We feel that our results are as yet not sufficient for a final report nor for any conclusions. But in describing the procedure, it is hoped that we may influence others to give their attention to this problem. With the exception of the work of Bartley (2) abroad, the field of direct visualization of calcified valves and the way they move has been neglected for want of a feasible and practicable technic.

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¹ From the Institute for Medical Research, Cedars of Lebanon Hospital, the Department of Medicine, University of California School of Medicine, Los Angeles, and City of Hope, Duarte, Calif.

² Made by North American Philips Company, Inc., Eindhoven, Holland, and supplied by the Henry N. Beets Co., Los Angeles, Calif.

³ Made and supplied by the L-W Photo Products Company, Los Angeles, Calif.

EDITORIAL

Outside Films: A Reappraisal

Increased public awareness of the hazards of ionizing radiation and of rising medical costs, two seemingly unrelated yet actually closely linked subjects, should foreshadow some new concepts and altered practices in the field of radiology.

It would appear that radiologists neither conform in policy nor display any uniformity of practice in consideration of previous x-ray studies. It is not to be denied that there are instances where earlier negative x-ray findings are not in accord with the current clinical findings and so a repeat roentgen examination may be necessary; even fluoroscopic studies in young adults are not precluded, if indicated. Too often, however, a radiologist cognizant of recent examinations, or unaware of them through failure to inquire, accedes to a request for new films though the earlier study had been reliable, satisfactory, and contributory. (Contributory studies are defined as those which the findings are not expected to change in a short time and which were either unequivocally positive or negative, in full agreement with the clinical data.) That fulfillment of requests for repetitious x-ray investigations is not uncommon is disturbing, especially when one realizes the possible portent.

Although radiologists have long recognized and been alert to the dangers of ionizing radiation, they have been placed in a further vulnerable moral position by the recent publicity given to these hazards. The profession must be ever conscious of the supreme importance of the genetic welfare of the young adult population. Need an upper gastrointestinal series in a young adult be repeated, for the "sake of the record," if a recent examination indubitably shows a duodenal ulcer? Is it necessary, especially in young people, that

a contributory lumbosacral spine roentgenogram, excretory pyelogram, or barium enema study be duplicated, chiefly to complete hospital records? Assuredly not, if alternatives to this practice can be developed.

Plans which offer unlimited x-ray services can result in excess radiation and are not in the best interests of the public. Radiologists, in all good conscience, should spur medical societies toward co-operative efforts for wiser control of x-ray benefits. Although the genetic welfare of the young is of primary import, the economic factor merits continuous surveillance. X-ray studies are not inexpensive and contribute measurably to the premium costs of health insurance plans. The medical profession is harried by ill-considered accusations of its indifference to costs and should, wherever possible, keep such expenses at a minimum. Many Blue Cross plans have unwittingly accentuated the problem. At the time of a repeat examination, the patient is led to believe that he individually is saving money and not being taxed financially if he has a hospitalization plan in which x-ray studies are fully indemnified. Increased premium costs due to this and other abuses could be carried to the point where rates for a satisfactory plan would be beyond the reach of the average family. This, in turn, could create an irresistible demand for government participation and control.

Some Blue Shield plans have attempted to lessen one abuse by offering partial or full indemnity for x-ray studies in a private office or hospital on an ambulatory basis. This, which is a step in the right direction to shift x-ray benefits from a hospital plan to a medical plan, will be of no avail if any appreciable number of patients again undergo roentgenography on admission to

a different hospital. Elimination of unnecessary x-ray studies is sought also in the interest of more efficient and better utilization of hospital beds, which almost everywhere are at a premium. The long waiting lists at many institutions offer conclusive evidence of the dire need of the optimum utilization of the facilities available to the patient which would either circumvent or shorten hospitalization.

Some radiologists are apparently under a misapprehension that there are medico-legal barriers to interpretation of "outside studies" or their incorporation in the hospital records. In answer to an inquiry, Mr. Joseph Stetler, director of the law department of the American Medical Association, states: "I do not believe that there are important legal reasons which prohibit the acceptance of x-ray studies made by a qualified radiologist in another office or institution."

There are radiologists who assiduously seek previous studies which could be helpful or could avert the necessity of a re-examination. Failure, however, on the part of the referring staff to notify the radiologist prior to or at the time of admission can result in the patient staying in the hospital needlessly until the outside studies are received. Further, in many cases, delay on the part of the referring staff to supply the radiologist with any information or clinical data may force the patient to be subjected to a needless duplicate examination.

In most institutions the principal liaison between the referring physicians and the radiological professional staff, prior to any x-ray examination, is limited to requisition forms. So that the day's work may be expedited, these requisitions are processed primarily through the nonprofessional staff. Improper transfer of pertinent data to the radiological professional staff can result in an incorrect x-ray procedure and thus lead to unnecessary exposure and expense. Proper clinical data, if available prior to an examination, could contribute to the most prudent technical procedure the radiologist

would advocate. Since consultations, in general, are held in the postexamination period, the efficacy of the radiologist's participation is thus limited. Consequently distinct potentialities for the beneficial interest of the patient are not procured.

Another area which could be infinitely improved is the loaning of "films" to authorized institutions or physicians. Recently a routine chest study of a young pregnant resident physician unexpectedly revealed a lesion in the upper lung field. She had only recently been an intern at a large out-of-state hospital where a chest examination had also been made. Try as the radiology department did, it could not obtain the loan of the previous films, only a copy of the report. Was there not violated in that institution the precept of doing what is best for the patient, whose welfare should be the primary concern toward which any policy is directed?

The remedies are not simple and pose many problems. So that hospital records may be more complete, it is incumbent upon radiologists to co-operate with and stimulate x-ray equipment manufacturers and photographic companies toward the development of rapid, simplified, and inexpensive film-copying apparatus. Copies made with such apparatus could be incorporated in hospital records. There is the added cost of an enlarged nonprofessional staff to process the recording, copying, and mailing of borrowed films. Even if there were a direct charge to the patient for this additional service, it would still be less than the expense of duplicate examinations. Further, the hazard of increased irradiation would be lessened. There should be a universal agreement on how to assess charges, if any, for the time required by the professional radiological staff to review and record "outside studies."

Again, of utmost importance is the education of our medical and surgical confreres so that the radiologist will be informed of previous studies. The following suggestions are offered:

- (1) Hospitals which forward pre-ad-

mission printed instructions to patients should supplement these with the request that, preferably before admission, any x-ray studies be brought to the hospital.

(2) The importance of properly limiting x-ray studies should be continually stressed to the referring staff.

(3) Because of the difficulty in procuring satisfactory clinical histories on requisition blanks, it might be advisable to add to all requisition forms a standardized section giving specific and definitive information to be obtained from both the patient and the referring physician. When such a section is not properly filled out, the requisition should not be honored.

(4) Hospital executive committees should be requested to insist that requisitions for radiologic service be completed in full.

Recommendations to others must in no way be understood to relieve radiologists of the responsibilities which are theirs. By their actions are they to be judged, and only by implementation of their suggestions can desired goals be reached. Therefore, let there be a code among them whereby freer communication is the order, where freedom in the loaning of films is the practice, and whereby, through their cooperative efforts in eliminating unnecessary x-ray examinations, they demonstrate a resistance to rising medical costs and, above all, the hazards of excessive radiation.

WILLIAM S. ALTMAN, M.D.
Quincy, Mass.

It is with deep regret that we report the death of Dr. C. Edgar Virden of Kansas City, Mo., Past-President of the Radiological Society of North America, while in attendance at the Annual Meeting of the American Roentgen Ray Society, in Washington, D. C. Further notice will appear in a forthcoming issue of RADIOLOGY.

ANNOUNCEMENTS AND BOOK REVIEWS

AMERICAN ROENTGEN RAY SOCIETY

At the Fifty-ninth Annual Meeting of the American Roentgen Ray Society, Sept. 30 to Oct. 3, in Washington, D. C., Dr. Barton R. Young assumed the Presidency and the following officers were elected: Dr. Edward B. D. Neuhauser, Boston, Mass., President-Elect; Dr. Franklin B. Bogart, Chattanooga, Tenn., First Vice-President; Dr. A. Bradley Soule, Jr., Burlington, Vt., Second Vice-President; Dr. C. Allen Good, Rochester, Minn., Secretary; Dr. Robert K. Arbuckle, Oakland, Calif., Treasurer.

Dr. Leo G. Rigler, Executive Director of Cedars of Lebanon Hospital, Los Angeles, and currently President of the Radiological Society of North America, delivered the Annual Caldwell Lecture.

BROOKLYN RADIOLOGICAL SOCIETY

Newly elected officers of the Brooklyn Radiological Society are Harold Schwinger, M.D., President; Sol Schwartz, M.D., Vice-President; George A. Manfredonia, M.D., 1 Hanson Place, Brooklyn, Secretary-Treasurer.

COLORADO RADIOLOGICAL SOCIETY

At a recent meeting of the Colorado Radiological Society, the following officers were elected for the ensuing year: President, Thomas J. Kennedy, M.D., Denver; Vice-President, Edward E. Tennant, M.D., Sterling; Secretary, Lorenz R. Wurtzbaach, M.D., 601 East 19th Ave., Denver; Treasurer, Charles Gaylord, M.D., Denver.

The Society meets the third Friday of each month at the Denver Athletic Club.

SECTION ON RADIOLOGY OF MEDICAL SOCIETY OF DISTRICT OF COLUMBIA

The Section on Radiology of the Medical Society of the District of Columbia recently elected the following officers: President, Joseph Belair, M.D.; Vice-President, George Tievsky, M.D.; Secretary-Treasurer, Charles E. Bickham, Jr., M.D., 1835 Eye St., N. W., Washington 6, D. C.

NORTH CAROLINA RADIOLOGICAL SOCIETY

At a recent meeting of the North Carolina Radiological Society, John E. Wear, M.D., of Salisbury, succeeded to the presidency, and the following were elected to office: Ignacio Bird-Acosta, M.D., Greensboro, President-Elect; Owen Doyle, M.D., Greensboro, Vice-President; Charles Bream, M.D., Department of Radiology, North Carolina Memorial Hospital, Chapel Hill, Secretary-Treasurer; Stuart

Gibbs, M.D., Gastonia, Executive Committee Member.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY

Newly elected officers of the Northeastern New York Radiological Society are: President, Kencil L. Mitton, M.D., Schenectady; Vice-President, Sidney I. Etkin, M.D., Albany; Secretary-Treasurer, Irving Van Woert, Jr., M.D., Albany Hospital, Albany, N. Y.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

At the recent annual meeting of the Rocky Mountain Radiological Society, the following officers were elected: George A. Unfug, M.D., Pueblo, Colo., President; Gerald S. Maresh, M.D., Denver, Colo., President-Elect; Peter E. Russo, M.D., Oklahoma City, Okla., First Vice-President; Paul E. Re Pass, M.D., Denver, Colo., Second Vice-President; John H. Freed, M.D., 4200 East Ninth Ave., Denver 20, Colo., Secretary-Treasurer; H. Milton Berg, M.D., Bismarck, N. D., Historian.

The 1959 meeting will be held Aug. 20-22 at the Shirley-Savoy Hotel, Denver.

ISOTOPE COURSE, QUEENS HOSPITAL CENTER, NEW YORK

A four-month course in Medical Uses of Radioactive Isotopes is being offered at the Queens Hospital Center, Department of Hospitals, City of New York, by the Radiation Medicine Department in cooperation with the Atomic Energy Commission, beginning Tuesday, Feb. 10, 1959. Weekly five-hour sessions will include lectures, laboratory exercises, and clinical management of patients. Tuition for the course is \$250.00.

Requests for applications should be sent to Dr. Philip J. Kahan, Supervising Medical Superintendent, Queens Hospital Center, 82-68 164th St., Jamaica 32, N. Y.

RADIOLOGICAL PHYSICS COURSE MEMORIAL CENTER, NEW YORK

Announcement of the graduate student program in Radiological Physics offered by the Department of Biophysics of the Sloan-Kettering Division of the Cornell University Medical College is made annually. The curriculum includes formal courses in physics, biology, physiology, chemistry, and radiation physics. Extensive laboratory training in treatment planning, implant dosimetry, applications of radioactive isotopes, measurement and calibration of isotopes and other radiation sources, and radia-

tion protection are offered. A thesis is also required for the M.S. degree. A limited number of fellowships are available. Requests for information should be sent to Department of Biophysics, Sloan-Kettering Institute, Memorial Center, 444 East 68th Street, New York 21, N. Y.

AWARDS IN RADIOLOGICAL RESEARCH JAMES PICKER FOUNDATION

On behalf of the James Picker Foundation, the National Academy of Sciences-National Research Council announces the continued availability of funds in support of radiological research. The program includes Grants-in-aid, Grants for Scholars, and Fellowships in Radiological Research.

Grants-in-aid are designed to encourage investigations offering promise of improvement in radiological methods of diagnosis or treatment of disease.

Grants for Scholars, a transitional form of support, are designed to bridge the gap between the completion of fellowship training and the period when the young scientist has thoroughly demonstrated his competence as an independent investigator.

Fellowships in Radiological Research are open to candidates seeking to gain research skills leading to investigative careers in the field of radiology.

Applications in these three categories for the fiscal year 1959-1960 should be submitted by December 1, 1958. Further details and application blanks may be obtained from the *Division of Medical Sciences—Room 411, National Academy of Sciences, National Research Council, 2100 Constitution Ave., N. W., Washington 25, D. C.*

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

CLINICAL RADIOLOGY OF ACUTE ABDOMINAL DISORDERS. By BERNARD S. EPSTEIN, M.D., Chief, Department of Radiology, The Long Island Jewish Hospital, New Hyde Park, N. Y., Associate Clinical Professor of Radiology, Albert Einstein College of Medicine, Yeshiva University, New York, N. Y. A volume of 352 pages, with 406 illustrations on 224 figures. Published by Lea & Febiger, Philadelphia, 1958. Price \$15.00.

RADIOACTIVE ISOTOPES IN CLINICAL PRACTICE. By EDITH H. QUIMBY, Sc.D., Professor of Radiology (Physics), College of Physicians and Surgeons, Columbia University, New York; SERGEI FEITELBERG, M.D., Director, Physics Department, The Mount Sinai Hospital; Associate Clinical

Professor of Radiology, College of Physicians and Surgeons, Columbia University, New York; and SOLOMON SILVER, M.D., Attending Physician; Chief, Thyroid Clinic, The Mount Sinai Hospital; Associate Clinical Professor of Medicine, College of Physicians and Surgeons, Columbia University, New York. A volume of 452 pages, with 97 figures. Published by Lea & Febiger, Philadelphia, 1958. Price \$10.00.

THE CERVICAL SYNDROME. By RUTH JACKSON, B.A., M.D., F.A.C.S., Clinical Assistant Professor of Orthopaedic Surgery, The University of Texas, Southwestern Medical School, Dallas; Attending Orthopaedic Surgeon, Baylor University Hospital; formerly Chief of Orthopaedic Surgery, Parkland Hospital, and Instructor in Orthopaedic Surgery, Baylor University College of Medicine, Dallas, Texas. A volume of 198 pages, with 90 figures. Published by Charles C Thomas, Springfield, Ill., 2d ed., 1958. Price \$6.50.

ORAL ROENTGENOGRAPHIC DIAGNOSIS. By EDWARD C. STAFNE, D.D.S., F.A.C.D., Senior Consultant, Section of Dentistry and Oral Surgery, Mayo Clinic, and Professor of Dentistry and Oral Surgery, Mayo Foundation, Graduate School, University of Minnesota, Rochester, Minn. A volume of 304 pages, with 1,338 illustrations on 423 figures. Published by W. B. Saunders Company, Philadelphia, 1958. Price \$14.50.

TUMORS AND TUMOROUS CONDITIONS OF THE BONES AND JOINTS. By HENRY L. JAFFE, M.D., Director of Laboratories and Pathologist, Hospital for Joint Diseases, New York, N. Y., Consultant, Armed Forces Institute of Pathology, Washington, D. C. A volume of 630 pages, with 701 illustrations on 194 figures. Published by Lea & Febiger, Philadelphia, 1958. Price \$18.50.

THE URETEROVESICAL JUNCTION; THE THEORY OF EXTRAVESICALIZATION OF THE INTRAVESICAL URETER. By JOHN A. HUTCH, M.D., Clinical Instructor of Urology, University of California, San Francisco. A volume of 178 pages, with 97 figures. Published by University of California Press, Berkeley 4, Calif., 1958. Price \$7.50.

HOT LABORATORY EQUIPMENT. Compiled by L. G. STANG, JR., Brookhaven National Laboratory operated for the U. S. Atomic Energy Commission. A monograph of 430 pages with 351 figures. (Enlarged version of Part II of Chemical Processing and Equipment (TID-5276), published by Atomic Energy Commission in 1955.) Published by Technical Information Service, Washington, D. C., 2d ed., 1958. For sale by Superintendent of Documents, U. S. Govt. Printing Office, Washington 25, D. C. Price \$2.50.

ANNUAL EPIDEMIOLOGICAL AND VITAL STATISTICS. 1955. PART I. VITAL STATISTICS AND CAUSES OF DEATH. PART II. CASES OF AND DEATHS FROM NOTIFIABLE DISEASES. PART III. STATISTICS OF HEALTH PERSONNEL, HOSPITAL ESTABLISHMENTS AND VACCINATIONS. (In English and French.) A volume of 700 pages, with 79 tables (1 in 51 parts). Published by World Health Organization, Palais des Nations, Geneva, Switzerland, 1958. Distributed in the United States by the Columbia University Press, New York 27. Price \$12.00.

LINFOPATÍAS TUMORALES: PATOLOGÍA, CLÍNICA Y TRATAMIENTO. By MANLIO FERRARI, Profesor titular de Patología Médica de la Facultad de Medicina de Montevideo; Internista del Instituto de Radiología y Ciencias Físicas, and HELMUT KASDORF, Profesor adjunto de Radiología de la Facultad de Medicina de Montevideo; Radio-terapeuta del Instituto de Radiología y Ciencias Físicas. A monograph of 204 pages, with 70 figures. Published by Lopez & Etchegoyen, S. R. L., Junín 863, Buenos Aires, Argentina, 1957.

Book Reviews

TUMORS OF THE SOFT SOMATIC TISSUES: A CLINICAL TREATISE. By GEORGE T. PACK, M.D., LL.D., F.A.C.S., Attending Surgeon, Memorial Center for Cancer and Allied Diseases; Associate Professor of Clinical Surgery, Cornell University Medical College; Surgeon, Pack Medical Group, New York; and IRVING M. ARIEL, M.D., F.A.C.S., Associate Clinical Professor of Surgery and Associate Attending Surgeon, New York Medical College, Flower and Fifth Avenue Hospitals; Surgeon, Pack Medical Group, New York. A volume of 820 pages, with 652 figures, 14 charts, and 109 tables. Published by Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, New York 16, N. Y., 1958. Price \$30.00.

This beautiful volume on tumors of the soft somatic tissues is the result of twenty-five years of experience by recognized authorities in oncological surgery. Amazing completeness has been achieved in all subject facets save radiation therapy. In this aspect of treatment, the authors do not pose as authorities; however, their generalities pertaining to irradiation are largely acceptable. Possibly their greatest contribution to the radiotherapist is a knowledge of the relative sensitivity of various rare tumors.

The book is divided into six sections. Section I is concerned with classification and natural history of the tumors, Section II with general principles of treatment, Section III with treatment of specific tumors, Section IV with sarcomas of infants and children, Section V with regional anatomic con-

siderations in treatment, and Section VI with prognosis.

As the title suggests, the volume is concerned with neoplasms of mesenchymal origin. In addition, the many desmoplastic diatheses are presented in a concise and complete form, most in monograph thoroughness. Each entity is approached from nosologic, ontologic, and histologic aspects. Important factors such as incidence and heredity are evaluated.

Surgical treatment for the lesions of given characteristics and specific locations are discussed and demonstrated with clarity. Techniques are described and forewarning is given of possible complications. The measure of success in the authors' experienced hands is recorded for the many situations encountered. The individual entities are illustrated by photographs, photomicrographs, and in many cases radiographs.

Throughout this volume, the reviewer is impressed with the extensive experience of the authors and the results which they have achieved. The reader will find every somatic soft-tissue tumor adequately presented, with an excellent bibliography for each. Specific differential factors of closely related tumors and eponyms are lucidly pinpointed. There is no doubt that this commendable work will be of vital interest to the general surgeon, the orthopedic surgeon, the oncologist, and, indeed, to anyone with a special interest in neoplasia.

RADIATION: WHAT IT IS AND HOW IT AFFECTS YOU. By JACK SCHUBERT and RALPH E. LAPP. A volume of 314 pages. Published by The Viking Press, New York, 1957. Price \$3.95.

Though popular treatises on radiation and its potential hazards do not ordinarily receive attention in these columns, it has seemed well to call to the attention of radiologists an example of the serious misunderstandings that are being fostered in the public mind and at least prepare them to answer intelligently the questions with which they will almost inevitably be faced. The following excerpts are from a review prepared by Dr. George Tievsky which appeared in part in the *Monthly News Letter* of the American College of Radiology.

"We agreed," say Doctors Schubert and Lapp, in an early page of this book, "that it was time to sound a warning against the radiation peril. We also agreed that this warning be given to the public rather than merely to technicians and doctors."

The knowledgeable reader wonders what special qualifications are possessed by these authors, enabling them to sound a strident alarm to the general public over the head of doctors and "technicians" (radiologists?). We must presume that their purpose is sincere, but their deep alarm is highly tinged with sensationalism throughout this book. Dr. Jack Schubert is a chemist by training, with experience in the biological effects of radioactive materials; he is not, however, a radiation biologist. Dr. Ralph

E. Lapp is a nuclear physicist, no longer active as such, but essentially a writer and publicist in the various fields of nuclear energy. Neither of these gentlemen has had personal experience with the clinical use of radiation on human beings nor did they secure the guidance of competent experts in the field of radiation health physics or medical radiology. In other words, they have done a most dangerous thing for specialists: wandered into areas without possessing a special competence enabling them to make authoritative statements and draw important conclusions.

Throughout this book they declare that the medical profession has gravely mishandled radiation. The authors have culled many specific instances of what they believe to be such episodes from the medical literature. The fact that these were originally contributed to point out certain of the hazards of radiation has apparently escaped them.

These pages lack a sense of balance—we do not read of the lives saved and the suffering relieved by the use of radiation since the discovery of the x-ray. By focusing solely on the potential danger of radiation and failing to present a balanced picture which includes its contribution to humanity, the authors have done both their lay readers and the medical profession a gross disservice. . . . There has been no attempt to convey to the reader the tremendous variation in biological effects of different types of radiation and the gross differences in effect due to dosage factors and tissue volume irradiated.

The concluding chapter presents the authors' plans for protecting the American public against this hazard of civilization. It is the feeling of the writers that control of radiation hazards by the various state governments will probably be of piecemeal variety; therefore Federal control of all radiation sources is the best answer to this problem. To this end, they suggest that the Congress enact a National Radiation Control Act which would be implemented by a Federal agency, designated as the Radiation Control Service. This agency would be concerned with all facets of the radiation problem including research, education, licensing, and inspection of all radiation sources, as well as the maintenance of records of every significant dose of radiation delivered to every patient in this country. On page 262, the authors make what seems to this reviewer a rather naïve statement: "It is not our intention to promote the development of the Radiation Control Service to a colossus which would tower over other agencies." It would be difficult to imagine a Federal agency having these responsibilities and powers which would not do precisely what the authors fear.

In so far as the position of the medical profession is concerned, the following are the authors' words as quoted from page 260: "It may be argued that the entire situation will be reshaped when the medi-

cal fraternity draws up a new code of radiation practice. There is something to be said for this procedure, since it is not a good practice for patients to recommend modes of treatment to the medical profession. It is our conclusion, however, that the excesses in radiation exposure of patients are already too well established as routine practice for them to be corrected intramurally."

Drs. Schubert and Lapp might be reminded that in 1928, under the auspices of the radiologists of the world, the International Committee on Radiation Protection was formed which subsequently formulated the basic standards of protection against radiation hazards. From that organization developed corresponding committees in every country over the world. In the United States the National Committee on Radiation Protection has developed a highly successful protection program which has been accepted and quite generally carried out, voluntarily, by radiologists during the past 25 years. These standards represented the foundation of the tremendously successful radiation control program of the Manhattan District Project which was responsible for the atomic bomb. The radiological safety measures which protected these two author-scientists in their work with radiation thus had their roots in our specialty.

This reviewer does not infer that there is no room for improvement among the medical and paramedical users of radiation. The educational campaign of the American College of Radiology which is directed toward nonradiological users of x-ray equipment represents recognition of this problem and the exercise of exemplary leadership in an interim effort to meet it. The full extent of the problem in nonradiological medical fields must be faced by the leaders of the profession. Unless this is done promptly the type of controls which these authors favor may well emerge. What is also needed is a sound program of public education emphasizing the constructive role of radiation in our society and its tremendous contribution to the highest standard of health the world has ever known. The alarm technic of these authors can scarcely be conceived as representing a significant contribution to the understanding of the radiation hazard question.

The presentation of complex knowledge to make it understandable and interesting is one of science's major problems. When social and scientific factors are intimately related the importance of bridging the gap between the jargon of the scientists and the relatively simple language of our mass communication media becomes infinitely important. The complex decisions which the citizens of our democracy must make, if this democracy is to endure in the age of science, will depend increasingly on how well that gap is bridged. The present work, in this reviewer's opinion, has not contributed to that end.

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Radiology of the Cranio-Cervical Region. H. B. Goettsch. J. belge de radiol. 40: 739-762, 1957. (In English) (St. Elizabeth Hospital, Tilburg, The Netherlands)

Congenital and acquired lesions in the cranial cervical region may produce symptoms by pressure involving the bulbar, cerebellar, and the most cranially situated cervical nerves. The clinical picture must be differentiated from syringomyelia, spastic paraplegia, multiple sclerosis, amyotrophic lateral sclerosis, subtentorial tumors, and cervical disk herniations.

Radiological examination of this region includes standard postero-anterior and lateral exposures of the skull, basal projections, projections in Towne's and Schüller's positions, tomography in the sagittal and frontal planes, and in some cases views in flexion and extension. Various angles and lines drawn on the films have been used for ascertaining deviations from the normal. The author lists the following:

- (1) Bogaard's angle, formed by a line drawn from the dorsum sellae to the basion (lowest point of the clivus), and a line from the basion to the most dorsally situated point of the foramen magnum (average: $127^\circ \pm 10^\circ$);
- (2) Welcker's angle, formed by a line from the nasion to the tuberculum sellae and thence to the basion (average: $135^\circ \pm 10^\circ$);
- (3) Bull's angle, formed by the intersection of the plane of the hard palate and the plane of the atlas;
- (4) McRae's plane, formed by the foramen magnum, of importance in determining the position of the dens;
- (5) Chamberlain's line, running from the most dorsal point of the hard palate to the posterior margin of the foramen magnum; and
- (6) McGregor's line from the same point on the hard palate to the lower border of the squama occipitalis;
- (7) Fischgold's lines, one between the lower margins of the two mastoid processes, and the other from the *sulcus bigastricus* on one side to that on the other side.

One must be careful in interpreting data obtained by measuring the above lines and angles. Values of 10-11 mm. below Chamberlain's line have been found to be associated with high occipital condyles, while values up to 7 mm. above this line have been associated with low occipital condyles, neither of which conditions appears to be of pathological significance. In evaluating lines and angles related to the hard palate it should be remembered that their position is influenced by the height of the palate and development of the maxilla.

According to Frioriep's theory the occipital bone arises from three occipital vertebrae, which fuse almost completely. The corpus of the third occipital vertebra, the proatlas, is an exception and is destined to form the tip of the dens. In the second year ossification appears in the corpus of the proatlas; in the twelfth year this fuses with the dens. The greatest part of the dens is formed by the corpus of the atlas, which fuses with the epistropheus in the sixth or seventh year.

Basilar Impression: The borders of the foramen magnum are introverted and a plane through the foramen lies in the interior of the skull. The impression can be complete or partial according to the situation of the left, right, anterior, or posterior margin. The atlas lies close to the base of the skull and the dens extends high upward. In some pronounced cases the axes of the petrosal bones are tilted.

Some of these patients have no clinical symptoms. At other times, or in combination with deformities, serious symptoms may occur. Basilar impression may be congenital but is also associated with certain diseases with severe decalcification of bone. It may occur in Paget's disease, osteomalacia, rickets, senile atrophy of the bones, renal rickets, hyperparathyroidism, osteogenesis imperfecta, chondro-osteodystrophy, cretinism, dysostosis cleidocranialis, destructive lesions of the skull due to inflammation or tumor, chronic hydrocephalus, and trauma.

Platybasia: In platybasia the angle of Welcker is enlarged. In addition to the flat clivus there is an elevated dens and the angle of Bull is also enlarged.

Hypoplasia of the clivus is caused by a disturbance in the development of the bodies of the first and second occipital vertebrae, which together represent the basi-occiput. The foramen magnum is enlarged; the upper margin of the dens lies in or above the plane of the foramen.

Deformation of the foramen magnum is usually associated with the other conditions being discussed. Except in the case of hypoplasia of the clivus the foramen magnum is nearly always constricted. In addition the lumen of the dural canal is often narrowed by dural bands.

Manifestations of an Occipital Vertebra: The most simple form of occipital vertebra is a persisting ossiculum terminale, which is essentially a small separate odontoid process. Other bones may be seen in this region. Sometimes the base of the skull shows a *processus paracondylicus* or *paramastoidens*.

Assimilation of the Atlas: In many cases only the posterior arch of the atlas is assimilated and the lateral exposure of the skull shows a large empty space between the occipital bone and the spinous process of the second cervical vertebra. There may be associated fusion of the second and third cervical vertebrae.

Congenital malformations of the nonassimilated atlas are caused by hypoplasia or aplasia of one of the nuclei of ossification. The most frequent is spina bifida.

Block-formation of the upper cervical vertebrae range from an isolated fusion of two cervical vertebrae up to the more complete fusions seen in the syndrome of Klippel-Feil.

Os odontoides: About the sixth year of life the bony center of the dens fuses with the second cervical vertebra. When fusion fails, the dens remains a separate ossicle, kept in place by its fibrous connection with the vertebra and the ligamentous part of the *annulus osteofibrosus*. This condition must be differentiated from fracture of the dens. It is potentially dangerous because, at a later age, the ligamentous fixation may be loosened, resulting in an instability of the joints.

Hypoplasia and Aplasia of the Dens: When the dens is partly or completely absent the stability of the joints in the craniocervical region is endangered.

Disturbances in the stability of the craniocervical region are demonstrated on radiographs in maximal flexion and extension of the skull, the most important clue being the position of the dens in regard to the foramen magnum. Next to this, the width of the atlanto-axial joint is significant. The normal maximal values are 5 mm. in children and 2 mm. in adults. Loosening of the osteofibrotic ring produces a widening

of the atlanto-axial joint and involves the risk of pressure on the spinal cord or disturbance of the circulation of the cerebrospinal fluid.

Nine roentgenograms; 1 diagram; 1 table.

CHARLES M. NICE, JR., M.D.
Tulane University

A Method of Sialography. Åke Gullmo and Gun Bööck-Hederström. *Acta radiol.* 49: 17-24, January 1958. (University Hospital of Lund, Sweden)

The authors describe their technic of sialography, utilizing a water-soluble contrast material. They object to previous methods because of heavy contrast filling of the parenchyma with resultant severe pain and swelling of the salivary gland thus examined.

Injections are made through a metal cannula provided with a metal flange which fits close to the duct orifice. Massage of the salivary gland to be examined fills the duct with saliva and excludes air bubbles. The cannula is then introduced and clipped in place. A polyethylene tube filled with the contrast medium (Urokon or Hypaque 60 per cent or more) is attached to the cannula and the flow of the medium occurs as the result of ordinary hydrostatic pressure (30 to 40 cm. H₂O). When 1 ml. has been introduced, the patient experiences a sense of fullness in the gland. Radiographic exposures are then made.

True anteroposterior views allow one to evaluate duct displacement. A satisfactory view of the posterior parotid ducts is obtained by tilting the chin 15° cephalad for the lateral projection.

Twelve roentgenograms; 4 photographs.

KENNETH D. DOLAN, M.D.
University of Missouri

THE CHEST

Experiences with Bronchography Using 3,5-Diiodo-4-Pyridone N-Acetic Acid (Dionosil). Charles T. Pinney, Daniel E. Wertman, and Billie B. Streete. *Am. Rev. Tuberc.* 77: 32-38, January 1958. (C. T. P., VA Hospital, Fort Douglas Division, Salt Lake City, Utah)

The authors review the results of 690 bronchographic studies in 536 patients in Fitzsimons Army Hospital, including the reactions to the procedure. Bronchography was done under local anesthesia and the medium was injected through a catheter placed in the bronchus to be studied. An average amount of 19 ml. per side was introduced. Dionosil Oily was used for 49 bronchograms, and aqueous Dionosil for the remaining 641. The oily material was employed largely in children, in whom general anesthesia was also used.

Sixty-two reactions were encountered, most of which were mild. Only 6 patients required medication for relief of dyspnea and wheezing. Intensive postural drainage was instituted because the reactions were believed to be caused or intensified by inadequate drainage; no serious reactions occurred after the more adequate drainage following the procedure.

The authors believe that Dionosil is a satisfactory medium for routine use in bronchography. It permits repeated bronchograms to be done with little hazard to the patients and, because of the rapid clearing of the material, there is no interference with subsequent roentgen examination of the chest.

Seven roentgenograms.

JOHN H. JUHL, M.D.
University of Wisconsin

The Solitary Circumscribed Pulmonary Nodule: Study of Seven Hundred Five Cases Encountered Roentgenologically in a Period of Three and One-Half Years. C. Allen Good and Theodore W. Wilson. *J.A.M.A.* 166: 210-215, Jan. 18, 1958. (Mayo Clinic and Mayo Foundation, Rochester, Minn.)

The histories of 705 patients with solitary circumscribed pulmonary nodules collected over three and a half years were analyzed, and grouped in four subdivisions: (1) cases in which calcium was demonstrable roentgenologically; (2) nodules known to be present without change in size for two years or longer; (3) cases in which the mass was presumed to be metastatic; (4) all others.

Calcification was present in 294, or 42 per cent of the 705 masses. Sixteen of this group were explored and found to be benign: 13 granulomas, 1 hamartoma, 1 simple cyst, and 1 neurofibroma. The evidence suggests that the rest were also benign.

Of the 37 lesions known to be present without change for two years or more, 2 were removed, and 1 of these was probably malignant. No conclusive information is available concerning the other 35.

One hundred and three masses were thought to be metastatic because of associated cancer elsewhere; 23 were proved histologically, and in 63 follow-up studies were indicative of malignancy; 5 nodules proved to be inflammatory in nature.

Of 271 masses not falling in the above categories, 143 were explored; 72 proved to be malignant.

If the entire group of 705 cases is considered, there were included 80 bronchogenic carcinomas (61 explored and 19 diagnosed on the basis of clinical and laboratory evidence), 10 bronchial adenomas, and at least 86 fairly well authenticated examples of metastatic neoplasm. The overall incidence of malignant disease is thus 25 per cent.

Four tables.

J. S. ARAJ, M.D.
Toledo, Ohio

Parenchymatous Pulmonary Lesions in Malignant Lymphogranulomatosis. L. Darcis. *J. belge de radiol.* 40: 763-772, 1957. (In French) (Université de Liège, Liège, Belgium)

Thoracic lesions in Hodgkin's disease, occurring in 40 to 80 per cent of all cases, are represented in order of frequency, by mediastinal, parenchymal, pleural, osseous, and cardiac lesions. Pulmonary parenchymal lesions are present in approximately 27 to 40 per cent of patients.

The pulmonary lesions may be very small and may be discovered only at autopsy. Others may appear during the course of the disease, as one of the many manifestations of dissemination. Occasionally the pulmonary lesions will be the primary manifestation of the condition.

Several types of radiologic picture are seen. Intra-bronchial proliferation of Hodgkin's lesions may cause emphysema or atelectasis somewhat similar to that of bronchial carcinoma. Generalized, segmental, or lobar infiltrates may simulate tuberculosis or pneumonia. Solitary and multiple nodules may suggest pulmonary metastases from other forms of malignant disease. Multiple small nodules may occur, resembling hematogenous or miliary tuberculosis. A fibrotic or sclerotic type may simulate pneumoconiosis to a certain extent. Occasionally a parenchymal lesion will undergo cavitation, making distinction from a tuberculous cavity,

pulmonary abscess, or ulcerating, excavating type of neoplasm difficult.

Twelve roentgenograms.

CHARLES M. NICE, JR., M.D.
Tulane University

Primary Leiomyosarcoma and Leiomyoma of the Lung. Review of the Literature and Report of Two Cases of Leiomyosarcoma. John W. Agnos and George W. B. Starkey. *New England J. Med.* 258: 12-17, Jan. 2, 1958. (J. W. A., Toronto General Hospital, Toronto, Canada)

A survey of the medical literature revealed reports of 14 cases of leiomyoma and 18 cases of leiomyosarcoma of the lung.

The benign tumors are usually asymptomatic and are found incidentally. Roentgenologic study may reveal a well defined round or oval mass. In 2 of the reported cases atelectasis was present. Treatment is surgical, with good results.

The malignant tumors gave rise to chest symptoms, as cough, dyspnea, pain, and sputum. Roentgen study reveals a mass with or without atelectasis. Bronchography may indicate a filling defect or narrowing. Bronchoscopy is likely to yield positive findings. The prognosis following surgery is somewhat better than for primary carcinoma of the lung.

In the two cases reported here pneumonectomy was performed and in both instances the hilar nodes were negative for metastases. One patient lived eighteen months and the other two months postoperatively.

Six roentgenograms; 2 photomicrographs.

JOHN F. RIESSER, M.D.
Springfield, Ohio

Bronchopulmonary Cysts and Their Malignant Degeneration. L. S. Rozentraukh and K. A. Golubeva. *Vestnik rentgenol.* 32: 29-31, March-April 1957. (In Russian)

Four cases of malignant change in bronchopulmonary cysts are reported. These cysts are frequently associated with a chronic inflammatory process, and carcinoma develops from the epithelial linings. In view of this possibility, they should be followed carefully by radiologists for signs of growth; uneven wave-like thickening of the cyst wall in a circumscribed area should be viewed with particular suspicion.

Three illustrations.

B. ABRAMSON, M.D., AND R. RIEBEL, M.D.
Columbus, Ohio

Lobar Emphysema. Harry W. Fischer, Joseph L. Lucido, and Chester P. Lynxwiler. *J.A.M.A.* 166: 340-345, Jan. 25, 1958. (H. W. F., State University of Iowa, Iowa City, Iowa)

This is a case report of a unilobar emphysema in a newborn infant. Thoracotomy and a right middle lobectomy proved to be curative. An excellent presentation of the clinical and radiographic findings as well as surgical and pathologic changes is given.

Paramount points in diagnosis are: (1) persistence of lung markings in a large radiolucent area whether this be all or part of the unilateral lung field; (2) the information obtained from bronchoscopy and the response of the patient to tracheobronchial aspiration, by which the more common atelectasis-compensatory emphysema complexes can usually be excluded.

Etiology is varied. About one-third of the reported

cases have been secondary to an abnormality of bronchial cartilage. Another possibility is a check-valve action of a mucous plug. The condition is not associated with prematurity. It is limited almost entirely to the upper and middle lobes.

Treatment is surgical. Only rarely is the course benign enough to allow continued conservative therapy and observation when typical roentgenographic findings are present.

Three roentgenograms.

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

Broncholithiasis Produced by Histoplasmosis. Gerald L. Baum, I. Leonard Bernstein, and Jan Schwarz. *Am. Rev. Tuberc.* 77: 162-167, January 1958. (Jewish Hospital, Cincinnati, Ohio)

The authors report 2 cases of broncholithiasis with subsequent expectoration of the broncholiths. The material was examined and *Histoplasma capsulatum* was found in the decalcified material in both instances. No complications arose in either patient, but the possibility of dissemination of the disease when calcified nodes erode into bronchi has not been excluded by previous experience. It is known that viable tubercle bacilli may be liberated when similar erosion occurs in tuberculosis. The authors believe, therefore, that every effort should be made to arrive at an etiologic diagnosis in patients with broncholithiasis in order to manage the underlying disease adequately.

Two roentgenograms; 1 photomicrograph; 1 photograph.

JOHN H. JUHL, M.D.

University of Wisconsin

An Uncommon Miliary Disease: The "Cardiac Miliary," a Focal Form of Pulmonary Hemosiderosis. R. Lasserre and M. Chauvet. *Schweiz. med. Wchnschr.* 88: 38-41, Jan. 11, 1958. (In French) (Med. Univ.-Klinik, Geneva, Switzerland)

Miliary lesions of the lungs usually suggest tuberculosis, sarcoidosis, carcinomatosis of the pleura, histoplasmosis, or coccidioidomycosis. The so-called "cardiac miliary," however, is relatively rare.

A case is reported in a thirty-seven-year-old man with a history of rheumatic fever at the age of six. When he was twenty-nine years old, a mitral stenosis with cardiac decompensation was discovered. At the age of thirty-three, there were three episodes of pulmonary embolism, hemoptysis, and cardiac failure with auricular fibrillation, as well as a right hemiplegia with aphasia due to cerebral embolism. This was treated with anticoagulants; but there remained aphasia and spastic paralysis of the extremities on the right side. At the age of thirty-four, cyanosis and dyspnea on exertion were noted.

Examination revealed arrhythmia, auricular fibrillation, right ventricular preponderance, a diastolic murmur, an accentuated systolic heart beat, and slight râles in both lower lung fields. The liver was slightly enlarged. Roentgen study disclosed cardiac enlargement with convexity of the left upper heart border and a bulge of the right heart border, hilar congestion, and miliary densities in both lower lung fields. Earlier films reviewed at this time also showed the presence of the miliary lesions, which had undergone little change over a period of seven years.

"Cardiac miliary," or pulmonary hemosiderosis secondary to mitral stenosis, is a chronic condition and

denotes a malignant type of cardiac decompensation. Knowledge of this entity is important as it avoids confusion with other miliary lesions of the lungs and prevents unnecessary biopsy. The history usually reveals preceding rheumatic fever with joint involvement, dyspnea on exertion, cyanosis, and recurrent pulmonary episodes with hemoptysis.

Physical examination of the lungs is frequently negative except for occasional basal râles. Sputum examination may reveal heart failure cells. Roentgenologically, miliary lesions are most conspicuous in the lower lung fields and may remain unchanged in appearance for long periods of time. This stationary feature is of value in the differential diagnosis.

Males are affected three times more frequently than females, although the underlying mitral heart lesion shows a female preponderance in a ratio of four to one.

The diagnosis of pulmonary hemosiderosis is based on the roentgen findings. Only symptomatic therapy is indicated in case of recurrent pulmonary infections. The condition does not constitute a contraindication to mitral valvulotomy.

Two roentgenograms.

ERNEST KRAFT, M.D.
Northport, N. Y.

Diffuse Interstitial Pulmonary Fibrosis (Hamman-Rich Syndrome) in an Allergic Patient: Report of a Case. Louis Tuft and Leonard S. Girsh. *Am. J. M. Sc.* 235: 60-66, January 1958. (Temple University Hospital and Medical School, Philadelphia, Penna.)

A single case of diffuse interstitial pulmonary fibrosis (Hamman-Rich syndrome) is reported in a forty-four year-old woman. She had a personal and family history of allergy but it was not possible to isolate a specific allergen. A chest roentgenogram showed diffuse interstitial pulmonary fibrosis and uniformly distributed nodular densities. The diagnosis was proved by a lung biopsy. "Continued prednisone therapy for a period of twenty months has resulted in marked symptomatic relief with coincident improvement in arterial oxygen saturation and slight, although definite, improvement in the roentgenographic picture."

Two roentgenograms; 1 photomicrograph.

HOWARD J. BARNHARD, M.D.
University of Arkansas Medical Center

Radiopaque Grass Heads in the Lung. Daniel M. Hays, Gertrude T. Huberty, and Bernard J. O'Loughlin. *Dis. of Chest* 33: 38-42, January 1958. (University of California Medical Center, Los Angeles, Calif.)

Following aspiration of panicles of certain grasses, known as "grass heads", the course may be either (a) spontaneous passage through the lung and thoracic cage to the exterior or (b) the formation of chronic lung abscess and/or bronchiectasis. The authors present two cases in which antibiotic therapy enabled the patients to tolerate the initial acute infection produced by these foreign bodies. In each case the history of aspiration went back a decade or more, and during the years the vegetable matter had become encrusted by calcium salts. The degree of opacity was sufficient for demonstration on an ordinary chest roentgenogram. Both foreign bodies were in the right lower lobe, the most common site, and were associated with bronchiectasis. Hemoptysis brought both patients to the hospital. Both were successfully treated by

resection of the foreign body together with the bronchiectatic pulmonary segments.

Four roentgenograms.

HOWARD J. BARNHARD, M.D.
University of Arkansas Medical Center

Pulmonary Arteriovenous Fistulas of the Medial Basal Segment of the Right Lower Lobe: A Note on Absence of Vascular Bruits. Israel Steinberg. *Dis. of Chest* 33: 86-92, January 1958. (New York Hospital-Cornell Medical Center, New York)

Classically, pulmonary arteriovenous fistulas are accompanied by vascular bruits. The author presents 2 cases of fistula of the medial basal segment of the right lower lobe without the characteristic bruit. He postulates that the absence of a bruit in such cases is due to the position of this lobe deep within the chest, where it is completely surrounded by the heart medially and other segments of the lung elsewhere.

The cases presented were proved by angiocardiology, though neither patient was operated upon.

Six roentgenograms; 2 diagrams.

HOWARD J. BARNHARD, M.D.
University of Arkansas Medical Center

Chylothorax Treated by Ligation of the Thoracic Duct and Studies in Thoracic Ductography. Joseph J. Garamella. *Arch. Surg.* 76: 46-53, January 1958. (737 E. 22d St., Minneapolis 4, Minn.)

Since the first successful thoracic duct ligation a decade ago (Lampson: *J. Thoracic Surg.* 17: 778, 1948) this form of treatment of chylothorax has been performed at least 40 times without a fatality. The author reports very fully a case of traumatic chylothorax complicating closure of an interventricular septal defect successfully treated by thoracic duct ligation and presents a number of thoracic ductograms obtained in cadavers to demonstrate the variations of thoracic duct anatomy. The findings in these studies are not described in the text, but are well demonstrated in the illustrations.

Sixteen roentgenograms; 1 graph; 1 table.

JOHN P. FOTOPoulos, M.D.
Hartford, Conn.

THE HEART AND BLOOD VESSELS

Roentgen Evidence of Normal Heart and Congenital Abnormality in Early Infancy. James Carter, George Cooper, Jr., Frank Dammann, and Fred Mitchell. *J.A.M.A.* 166: 337-339, Jan. 25, 1958. (J. C., Box 3425, University, Va.)

Since it is not actually possible to define the limits of normal for the cardiac shadow in the newborn infant, any concern about the heart aroused by the chest roentgenogram obtained during the first twenty-four hours of life should not be shared with the parents until the presence of an abnormality is substantiated by other findings. The chest roentgenogram in the first few hours of life, with rare exceptions, is as unreliable in the detection of the type of cardiac abnormality as it is in defining the limits of the normal heart.

The authors' contribution to this subject consists of a review of the chest roentgenograms of 1,000 infants obtained within twenty-four hours after birth. This showed clearly that two technical factors prevent uniformity. One is the difficulty of eliminating rotation. A newborn infant is not co-operative about

holding the position in which he is placed. Most of the chest roentgenograms, even those taken by the best of technicians, show some rotation, and this alters the cardiac silhouette. The radiologist, expecting to see a true anteroposterior projection, may easily misinterpret the part played by unnoticed rotation in producing an unexpected cardiac contour. The other difficulty is that the technician cannot always make the exposure during full inspiration. Respiration is too rapid and irregular. The ready response of the mediastinal structures of the newborn infant to changes in intrathoracic pressure leads to marked changes in the silhouette during different phases of respiration.

Only when there is clinical evidence of cyanotic congenital heart disease are the roentgenographic findings of some value. Most cyanosis in the first twenty-four hours of life, however, is not of cardiac origin but is due to pulmonary disease.

The best one can do in these young patients is to give an intelligent guess based on extremely meager data and knowledge of the natural history of a particular malformation.

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

Congenital Stenosis of the Aortic and Pulmonary Valvular Areas of the Heart. Indications for Early Surgical Relief. Arthur J. Moss, Forrest H. Adams, Harrison Latta, Bernard J. O'Loughlin, and William P. Longmire, Jr. *J. Dis. Child.* 95: 46-52, January 1958. (A. J. M., 5830 Overhill Drive, Los Angeles 43, Calif.)

The authors present case histories of 2 children with severe valvular pulmonic stenosis and 1 with pronounced subaortic stenosis. These cases illustrate the importance of early diagnosis and surgical relief in patients with advanced degrees of obstruction. Two of the children died, 1 while hospitalized and awaiting surgery. The third, with pulmonic stenosis, recovered after emergency surgery. The pulmonic lesion referred to is severe valvular stenosis with an intact ventricular septum with or without a right-to-left atrial shunt.

The indications for special diagnostic studies, particularly for right heart catheterization, are signs of diminished exercise tolerance or abnormalities of the electrocardiogram or roentgenogram. The age, size, or weight of the patient should not influence the decision to obtain definitive studies. A policy of watchful waiting may be far more hazardous than one of intensive diagnostic study including cardiac catheterization and selective angiocardiology.

It is the authors' feeling that any child with aortic or subaortic stenosis should have the benefit of surgery, regardless of his age, if he has a history of syncope or exercise intolerance or has pronounced cardiac enlargement determined by electrocardiographic or roentgenographic studies. If cardiac failure is imminent, surgery should be performed as an emergency procedure.

The indications for operative relief of pulmonic stenosis are present if the patient shows signs of exercise intolerance, if the systolic pressure in the right ventricle is 75 mm. of mercury or more, or if cardiac failure threatens. Of particular importance is the clinical observation of a murmur which diminishes in intensity with continued observation, since this indicates that right ventricular failure is imminent.

Four roentgenograms; 1 photograph.

THEODORE E. KEATS, M.D.
University of Missouri

Endocardial Fibroelastosis; Angiocardiographic Studies. Leonard M. Linde, Forrest H. Adams, and Bernard J. O'Loughlin. *Circulation* 17: 40-45, January 1958. (University of California School of Medicine, Los Angeles, Calif.)

Four cases of endocardial fibroelastosis (1 confirmed by autopsy) were studied by biplane angiocardiography. Simultaneous electrocardiography enabled the authors to time systole and diastole with precision.

The striking angiocardiographic finding was the unchanging size and shape of the left ventricle in all phases of the cardiac cycle. This observation has not been recorded in cases of cardiac enlargement due to other causes and may be specific for this condition, although some entities, such as glycogen storage disease, idiopathic myocarditis, and an aberrant left coronary artery, have not been examined angiocardiographically. The authors postulate that the endocardial thickening acts as a splint in preventing contraction of the myocardium.

Eighteen roentgenograms; 1 table.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Rheumatic Tricuspid Stenosis. J. F. Goodwin, S. M. Rab, A. K. Sinha, and Max Zoob. *Brit. M. J.* 2: 1383-1389, Dec. 14, 1957. (Hammersmith Hospital, London, England)

A review of 21 cases of proved organic disease of the tricuspid valve is presented, with detailed discussions of the physical findings, cardiography, hemodynamics, pathological findings, and clinical picture.

Teleradiograms were available in 13 cases. The dominant feature was right atrial enlargement, beyond normal limits in nearly all cases, and greater than that seen in rheumatic heart disease without tricuspid stenosis in half the cases. Right ventricular hypertrophy could not be reliably demonstrated in the presence of marked right atrial enlargement and was assessed cardiographically. The authors show graphically the variation in the size of the right atrium in normal adults compared with patients with rheumatic heart disease without tricuspid stenosis and those with organic tricuspid valve disease.

It was found that right atrial enlargement was often considerable or gross when right ventricular hypertrophy was absent or slight. The cardiogram provided the best index of right ventricular dominance, and the roentgen film of right atrial size. The association of appreciable right atrial enlargement but little right ventricular hypertrophy on the cardiogram is particularly characteristic of tricuspid stenosis.

Fourteen figures, including 3 roentgenograms.

FRANK T. MORAN, M.D.
Auburn, N. Y.

Pulmonic Stenosis Produced by Compression of Heart by Anterior Mediastinal Tumor. Benjamin Winter. *Am. Heart J.* 55:18-26, January 1958. (6423 Wilshire Blvd., Los Angeles 48, Calif.)

The author presents a case of pulmonic stenosis produced by compression of the heart by an anterior mediastinal tumor. A 21-year-old white man one week before admission had an episode of pain beneath the upper part of the sternum. On physical examination he was dyspneic and during his first night in the hospital showed orthopnea, severe air hunger, and cardiac irregularity.

Roentgen examination of the chest showed what was considered to be marked dilatation of the main pulmonary artery and its branches. There was, however, a somewhat puzzling, vague double-contour shadow in the area of the pulmonary conus. At this point the provisional diagnosis was congenital heart disease with pulmonic stenosis and poststenotic dilatation of the main pulmonary artery trunks.

Catheterization corroborated the clinical impression of pulmonic stenosis, but there was still doubt as to the actual diagnosis. Angiocardiography demonstrated the pulmonary artery and its main branches to be normal. The superior mediastinal shadow was superimposed over the great blood vessels but never opacified, indicating that this shadow was not of vascular origin but represented an anterior mediastinal mass.

Thoracotomy was performed and a large mediastinal tumor, extending from the thyroid above to well down over the pericardium below, was found. The inferior border of the mass was densely adherent to the pericardium but was dissected free. This portion was found to be partly cystic. Laterally there were two large egg-shaped masses extending deeply into the right and left hili of the lung and centrally compressing the heart.

Histologic examination of the tumor showed it to be of thymic origin. Microscopically it showed the typical pleomorphic pattern of Hodgkin's disease with lymphoid elements, eosinophils, atypical reticulum cells, Reed-Sternberg cells, lipid histiocytes, and giant cells.

Following a course of radiation therapy, the patient was discharged and has remained well since.

Fourteen figures, including 9 roentgenograms; 1 table.

THEODORE E. KEATS, M.D.
University of Missouri

The Pulmonary Veins in Mitral Stenosis. M. Simon. *J. Fac. Radiologists* 9: 25-32, January 1958. (Diagnostic X-Ray Department, Guy's Hospital, London, England)

The author discusses the appearance of the pulmonary veins in mitral stenosis. In patients with mitral disease the upper lobe veins usually become engorged while the lower lobe veins remain within normal limits or may even be narrowed.

In the study reported here the author evaluated the degree of engorgement of the upper lobe veins in 63 unoperated cases and correlated this with pulmonary artery pressure and pulmonary resistance. It was apparent that the degree of venous engorgement was not directly proportional to the pulmonary venous pressure. It appears, therefore, that venous engorgement cannot be used on its own as an indication of pulmonary venous pressure. It may, however, provide a useful index when considered together with septal lymphatic lines or peripheral arterial changes described by other authors, since both occur predominantly in the relatively high-pressure groups. Thus, if there are no septal lines and the peripheral vessels show little change, the engorgement of the upper veins is in one of the relatively low-pressure groups. Conversely, if septal lines are present or if the peripheral vasoconstrictive changes are marked, or both, then the engorgement of the upper lobe veins is probably in one of the relatively high-pressure groups.

The author points out that in some cases venous engorgement persists after successful valvulotomy and the degree of venous congestion may decrease in

cases with the most severe venous hypertension. They suggest the following explanation:

1. There is reasonable evidence to postulate the existence of a simple reflex which is initiated by the rise of pulmonary venous pressure above a critical level and which results in peripheral venous and arteriolar vasoconstriction in a very localized portion of lung.

2. In the erect position pulmonary venous pressure is obviously higher in the lower lobes than in the upper lobes, due to the difference in hydrostatic pressure.

3. Thus in mitral stenosis venous hypertension is initially mild in the upper lobes, but marked in the lower lobes. Vasoconstriction thus occurs in the lower lobes, reducing the circulating volume through them.

4. Cardiac output, which varies little between mild and fairly severe cases, is maintained by increased flow through the upper lobes, producing engorgement of the upper lobe veins. Thus the engorgement in the upper lobes is primarily due to increased flow due to basal vasoconstriction and not directly to increased venous pressure resulting from the mitral obstruction.

5. The functional vasoconstriction is gradually and progressively superseded by organic changes which result from sustained venous hypertension.

6. The changes in the vessels, spastic or organic, progress upward from the lung bases as venous pressure increases, eventually involving the upper lobes.

7. The most advanced cases thus undergo reduction of the circulating volume even through the upper lobes, with consequent decrease of the engorgement of the upper lobe veins. This may be associated with reduction of cardiac output.

Eleven roentgenograms; 1 diagram; 2 charts; 1 table.

THEODORE E. KEATS, M.D.
University of Missouri

The Haemodynamic Significance of Intrapulmonary Septal Lymphatic Lines (Lines B of Kerley). Peter R. Fleming and M. Simon. *J. Fac. Radiologists* 9: 33-36, January 1958. (Guy's Hospital, London)

The data of 99 cardiac catheterizations on patients with mitral valve disease were studied in relation to the degree of prominence of septal lymphatic lines in films taken within fourteen days of catheterization. Lines were seen with at least equal frequency in pure mitral stenosis and in mitral stenosis complicated by mild or moderate mitral incompetence. In pure mitral stenosis, the mean pulmonary capillary pressure and its derivative, the mitral valve area, were more closely related to the presence of these lines than the mean pulmonary artery pressure or the pulmonary arteriolar resistance. The significance of the relationship was not, however, sufficiently high to permit an accurate prediction, from the lines alone, of the pulmonary vascular pressures measured at cardiac catheterization. It is probable that, if well marked lines are present, the mitral stenosis is sufficiently severe to warrant valvulotomy.

Three roentgenograms; 2 charts; 3 tables.

THEODORE E. KEATS, M.D.
University of Missouri

Persistent Left Superior Vena Cava Demonstrated by Angiocardiography. Bernard H. Pastor and Bernard I. Blumberg. *Am. Heart J.* 55: 120-125, January 1958. (VA Hospital, Philadelphia, Penna.)

The authors report an example of a persistent left superior vena cava discovered in the course of pre-

operative evaluation of a patient for aortic valve surgery. The presence of the anomaly suggested that the aortic valve lesion might also be congenital.

The clinical findings were typical of severe aortic stenosis except for preservation of the aortic second sound. Roentgen examination of the heart revealed the presence of left ventricular enlargement and moderate enlargement of the left atrium. Calcification of the aortic valve was demonstrated by planigraphy. Angiocardiography was attempted to determine whether associated mitral stenosis was present, the catheter being introduced into a vein in the left antecubital space. The injection of contrast material was made with great difficulty, an unusual amount of resistance being encountered. The serial films showed opacification of an anomalous venous channel in the position of a persistent left superior vena cava, which entered the right atrium by way of the coronary sinus. The injection was repeated through the right arm and a normally situated vena cava entering the right atrium was demonstrated.

The most common variety of persistent left superior vena cava, in which the anomalous vein drains into the coronary sinus, is readily explained on embryologic grounds. It has been attributed to failure of anastomosis to develop between the inferior cardinal veins.

This rare anomaly produces no physiologic disturbance unless there are associated malformations, or unless the anomalous vein enters the left atrium. It may, however, interfere with successful cardiac catheterization, produce obstruction at the time of cardiac surgery, or call attention to the presence of other congenital malformations.

Four roentgenograms; 1 diagram; 1 table.

THEODORE E. KEATS, M.D.
University of Missouri

Coarctation of the Aorta Proximal to Both Subclavian Arteries. Case Report of a Six-Year-Old Girl. I. Brynolf, C. Crafoord, and E. Mannheimer. *J. Thoracic Surg.* 35: 123-130, January 1958. (Karolinska Sjukhuset, Stockholm, Sweden)

The case of a 6-year-old girl is reported in whom there was found a rare combination of cardiovascular anomalies.

By means of physical examination (a palpable pulse was absent in both the radial and the femoral arteries), roentgenograms, and angiocardiography, a coarctation of the aorta proximal to both subclavian arteries was found with a right aortic arch and left descending aorta. At operation the coarctation was resected and the aorta, which ran behind the esophagus, was transposed to run in front of the trachea.

The embryology and pathogenesis of the anomalies are well discussed. The authors point out the recent trend to operate on coarctation of the aorta at an early age.

Four roentgenograms; 5 diagrams.

FRANK T. MORAN, M.D.
Auburn, N. Y.

Anomalous Right Subclavian Artery Arising Distal to a Coarctation of the Aorta. Richard F. Slager and Karl P. Klassen. *Ann. Surg.* 147: 93-97, January 1958. (Ohio State University Health Center, Columbus, Ohio)

The authors report a rare congenital anomaly, namely an anomalous right subclavian artery arising

distal to a coarctation of the aorta. Only 5 such cases were found in the literature.

The patient was a 45-year-old woman who complained of headaches, weakness, and a pulsating mass in the right base of the neck. Physical exercise produced symptoms of intermittent claudication of the right arm and both legs. On examination, a systolic murmur was heard over the left third parasternal interspace. Blood pressure was 90/45 mm. Hg in the lower extremity, 100/50 in the right upper extremity, and 230/80 in the left upper extremity. Roentgenograms showed left ventricular enlargement, notching of the left fourth and sixth ribs, and indentation of the esophagus above the aortic notch. A transcarotid aortogram revealed the coarctation and a small right subclavian artery distal to it.

The triad of hypotension of the right upper and lower extremities, hypertension of the left upper extremity, and absence of murmur over the right scapula are believed to be indicative of this anomaly.

In the authors' patient, resection of the coarctation with end-to-end anastomosis of the aorta and ligation of the anomalous right subclavian artery resulted in normal blood pressures in both upper and lower extremities.

Four figures, including 1 roentgenogram.

J. S. ARAJ, M.D.
Toledo, Ohio

Venous Angiocardiographic Diagnosis of Acute Dissecting Hematoma of Aorta (Dissecting Aneurysm).

Louis A. Soloff, Jacob Zatuchni, Herbert M. Stauffer, and R. Robert Tyson. *Arch. Surg.* 76: 116-122, January 1958. (L. A. S., Temple University Medical Center, Philadelphia, Penna.)

Acute dissecting hematoma of the aortic wall is now potentially curable by surgery. Without surgery more than one-third of persons so afflicted will die within forty-eight hours and about two-thirds within ten days. On the other hand, an exploratory operation may carry an even greater risk because of the considerable number of serious diseases which mimic this lesion clinically.

Although the clinical syndromes of acute dissecting hematoma of the aortic wall have been well documented, these are not definitive, and the incidence of correct clinical diagnosis in any specific series remains disappointingly low. Nor have the conventional roentgenographic criteria for diagnosis lived up to the expectations originally raised. This paper describes three instances of acute dissecting hematoma to show that venous angiocardiography is a safe procedure which supplies a diagnostic picture. A fourth case illustrates the angiocardiographic pattern of a combination of an aneurysm of the aorta and healed dissecting hematoma.

The diagnostic angiocardiographic pattern shows two aortic lumens, a true one and a false one. The densely opacified main aortic channel gives rise at the site of dissection to two lumens, usually separated by a thin layer of radiolucency. The true lumen has smooth borders and is as densely opacified as the main aortic channel, but in the absence of aneurysmal dilatation is usually narrower. This narrowing is usually greater from front to back and from side to side. The false lumen is represented by a mass which surrounds the true lumen and compresses it variably. The opacification of the mass is usually slight because of minimal or

no concentration of contrast substance within it. The outer border of the false lumen is usually parallel to or more convex than its inner border. The width may be uniform or there may be outward convexity, with the greatest width proximally, depending upon the degree of dissection and the integrity of the outer aortic wall. Tapering may occur at one or both ends, varying with the extent of dissection.

Final disappearance of the false lumen distally may signify its re-entry into the true lumen or blind termination of the dissection. With atherosclerosis, irregular widening of the false lumen may be seen. If irregularity occurs in a localized region, a dissecting hematoma within an aortic aneurysm is likely to be present.

It is the presence of a "soft-tissue" density adjacent to the "aorta" which makes it difficult to differentiate by conventional means a dissecting hematoma and an aneurysm. The difference is easily resolved by angiography, for with sacular and fusiform aneurysms there are, respectively, abrupt and gradual increases in size of the aortic lumen of localized extent, with equal or greater opacification than of the aorta. Moreover, surrounding "soft tissue" density either is not found or, if present, is uniform in width and usually thin. In contrast, in dissecting hematoma the surrounding density is less opaque than the main aortic channel and has considerable width, which is not uniform.

Five roentgenograms, 1 photograph.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

Pulmonary Artery Stenosis. Margaret B. Vermillion, Leonard Leight, and Lawrence A. Davis. *Circulation* 17: 55-59, January 1958. (University of Louisville School of Medicine, Louisville, Ky.)

Two cases of congenital peripheral pulmonary stenosis were studied by cardiac catheterization and biplane angiography. This condition has been recognized only since 1953 and so far all cases have been in infants or children. There appears to be no reason, however, why in some cases this abnormality should not be compatible with a relatively long life span.

The authors' first patient was ten years of age, showing considerable retardation of development as compared with her twin sister. A continuous murmur was heard at the second right intercostal space. On plain films the heart appeared normal in size but there was marked bulging of the pulmonary artery. Cardiac catheterization showed a high ventricular septal defect and right ventricular and pulmonary hypertension. Angiography following injection of an opaque medium into the right ventricle revealed the stenotic area in the branch of the pulmonary artery to the right upper lobe with moderate poststenotic dilatation.

The second patient was nineteen months old and also showed retarded development. Plain films demonstrated some cardiac enlargement and a possible increase in pulmonary vascularity. Pressure tracings from cardiac catheterization showed both a valvular and peripheral pulmonary stenosis. Angiography, as used in the first patient, again showed the stenotic area, this time in the main right branch, just beyond the bifurcation.

Four roentgenograms; 1 pressure tracing; 2 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Vertebral Arteriography Using the Sheldon Needle and Modifications of It. G. F. Swann. *Brit. J. Radiol.* 31: 23-27, January 1958. (Radiological Department, National Hospital, Queen Sq., London, W. C. 1, England)

The author describes his experience in vertebral arteriography using the Sheldon needle and a modification of it. The use of this needle has, in his opinion, converted vertebral arteriography from an uncertain, time-consuming, and sometimes frustrating procedure to a not difficult maneuver comparable with carotid puncture.

The Sheldon needle is made with an aperture in its lateral aspect, the distal end being closed. The author's modification has a smaller side aperture and a trocar cutting point is substituted for the ordinary beveled point.

In any arterial puncture the ideal position for the needle point is such that the aperture is directed up the long axis of the lumen of the artery. It is impossible to achieve this when puncturing the vertebral artery with a conventional needle because the surrounding bone prevents the needle from entering the artery anywhere near parallel with its direction, and the puncture has to be made at an angle approaching a right angle. It is, therefore, difficult to direct the stream of contrast up the lumen of the artery. However, with the Sheldon needle, the contrast medium emerges from the side aperture, thus tending to flow in approximately the direction of the blood stream up the artery. With the smaller side aperture, there is less tendency for the needle to be driven out of the arterial lumen by the recoil force of the injection.

A 94 per cent success rate was attained with the modified Sheldon needle as compared to 60 per cent with a conventional needle. Complications with the modified needle were less frequent.

Five roentgenograms; 6 drawings; 1 table.

THEODORE E. KEATS, M.D.
University of Missouri

Arteriography of the Upper Extremity. Caldwell J. Gaffney, Falls B. Hershey, and William E. Allen, Jr. *Surg., Gynec. & Obst.* 106: 63-69, January 1958. (Washington University School of Medicine, St. Louis, Mo.)

Percutaneous injection of the subclavian artery with Miokon (sodium diprotrizoate) was found to be a safe and convenient means for the demonstration of the upper extremity in 19 cases examined in the eighteen months prior to this report.

The skin is anesthetized above the clavicle where the subclavian artery is palpable, and a Courmand needle, size 20 or larger, is inserted perpendicular to the clavicle for a depth of about 3.0 cm. Brachial plexus paresthesia indicates that the needle is too far lateralward. If the first rib is encountered, the needle is "walked" along the rib laterally until it reaches the artery. The arterial pulse may be felt through the needle, and the artery is then pierced and the stylet withdrawn. The needle hub is directed 45 to 60° medially and posteriorly and then advanced 1 or 2 cm. further within the lumen. A syringe is attached and the arteriogram is obtained following injection of 20 to 30 cm. of 30 per cent sodium diprotrizoate in ten seconds or less. The first film is taken toward the end of the injection, followed by serial films at intervals of one to three seconds.

The arm is held in slight abduction and the forearm position is selected according to the needs of the examination. The radial and ulnar arteries are not obscured by bony shadows when the forearm is rotated 90°. The palmar arch and digital vessels are best visualized when the hand is pronated or supine. When the hand is supine, however, the distal brachial artery is covered by the lower humerus.

In 4 of the 19 cases arteriograms were obtained after end-to-end brachial artery anastomosis, in the early postoperative period; 4 studies were made because of arterial insufficiency due to old injury; 6 followed acute arterial injury; and 5 were done for Buerger's disease or other occlusive disease of the hands. There were no complications or significant arterial spasm. The procedure was helpful in determining arterial status.

Twelve roentgenograms; 7 diagrams; 1 table.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Complications of Aortography. James E. Anthony, Jr. *Arch. Surg.* 76: 28-34, January 1958. (348 W. Ponce de Leon Ave., Decatur, Ga.)

The author briefly reviews the history of aortography, including mention of some of the reported complications. Although hundreds of aortograms have been done, only a few deaths have been recorded. These have been attributed to superior mesenteric artery thrombosis following the entry of a large amount of contrast material into this artery, renal damage with changes in the glomeruli and tubules of the kidneys on the basis of a toxic reaction from acute heavy metal poisoning, and coronary infarction as a result of lowered blood pressure. Although fatal complications are rare, nonfatal sequelae which may be serious and result in permanent disability are not nearly as uncommon.

The author classifies complications as follows:

- A. Effects due to anesthesia.
- B. Complications due to the puncture, with local hemorrhage, loosening of aortic plaques with embolism, pain, and puncture of organs other than the aorta.
- C. Complications due to medium used.
 1. Sensitivity.
 2. Injection of medium into celiac or renal vessels with necrotizing effect, mesenteric thrombosis, hemorrhagic gastritis, or thrombosis of anterior spinal arteries with paraplegia.
 3. Activation of tuberculous processes by iodide.
 4. Lowered renal function.
 5. Distant vasospasm with thrombosis of femoral artery.
- D. Miscellaneous complications such as lowered blood pressure with coronary or cerebral thrombosis, neurogenic hyperexcitability, and temperature rise.

Six cases of complications of aortography observed at Presbyterian Hospital of Chicago in a series of about 100 aortograms are reported.

The first patient had a left hemothorax and left perinephric abscess following aortography. It was thought from the film study that the needle could have passed through the tip of the superior pole of the left kidney, as well as the diaphragm, into the aorta at the time of puncture.

The second patient, a 64-year-old Negro woman, exhibited paraplegia the morning after an aortographic study which had shown extravasation of the medium along the left psoas muscle. Partial recovery ensued and the patient could walk fairly well with support of a cane. Paraplegic injuries after aortography are thought to be due to a large concentration of the medium in the spinal cord vessels. This is often increased in cases of aortic obstruction. In other patients the complications consisted of severe abdominal and back pain, necessitating hospitalization in one patient, a probable chemical pyelonephritis with recovery in a patient in whom the renal vessels received a large concentration of medium, and a mass in the left flank attributed to a retroperitoneal hematoma.

The author concludes that his experience of 6 per cent complications suggests that a true picture of the safety of translumbar aortography cannot be obtained from the literature. He mentions as among the indications for the procedure: (1) complete ureteral obstruction if intravenous pyelography shows nothing and catheterization cannot be done; (2) preoperative determination of the vascular pattern of a kidney to determine whether the kidney may be partially salvaged; (3) differentiation of renal cysts from tumors; (4) demonstration of aberrant vessels; (5) Leriche's syndrome or evidence of unilateral or bilateral iliac artery occlusion. Contraindications are (1) acute coronary occlusion or cerebrovascular accident, (2) impaired renal function, (3) skeletal deformity, making puncture of the aorta difficult or impossible, (4) allergy, (5) cachexia, (6) poor hepatic reserve, (7) bleeding states, (8) advanced tuberculosis, (9) hyperthyroidism, and (10) any case in which the information to be obtained is insufficient to justify the risk.

JOHN P. FOTOPoulos, M.D.
Hartford, Conn.

Hazards of Arteriography. P. H. Klingenberg. *Arch. Surg.* 76: 54-57, January 1958. (VA Center, 4100 W. Third St., Dayton, Ohio)

A review of the literature of peripheral arteriography has shown complications of percutaneous arterial catheterization to be those of local hemorrhage, hematoma formation, arteriovenous fistula, thrombosis of the femoral artery, arterial spasm, traumatic damage to the arterial wall, arterial rupture or dissection, and reactions to the various media.

In a series of 47 aortograms and 16 peripheral arteriograms, the author encountered the following complications: (1) acute renal failure following introduction of a large amount of medium into the renal vessels due to block of the aorta; (2) segmental gangrene of a portion of the thigh following femoral arteriography; (3) cardiac arrest due to laryngospasm during Pentothal anesthesia; (4) extravasation, which is ordinarily innocuous; (5) thrombosis of the femoral artery; (6) transitory nonfunction of one kidney. In 3 cases the complication was considered serious. One of these is reported.

The patient was a thirty-seven-year-old man who had had a considerable soft-tissue shrapnel injury of the right thigh with some diminution in pulsations prior to arteriography. In the course of right femoral percutaneous arteriography with 30 c.c. of 75 per cent Urokon, extravasation of some of the medium occurred. Moderate thigh pain followed on the same day but pulsations were unchanged. Cyanosis of the lateral

aspect of the right thigh was apparent the following day. The skin remained discolored but viable when the patient was discharged twenty days after the study. He had to be readmitted to the hospital about a month later because of gangrenous slough in the area. The author believes that arteriospasm in an extremity already deficient in blood supply as a result of previous trauma contributed significantly to the occurrence of gangrene in this case. Other factors which contribute to complications include the irritant effect of the contrast material on the intima, both chemically and as a foreign body; speed of injection and concentration of the medium; the size of the lumen of the vessel and distal obstruction by disease; severe or prolonged vascular spasm producing thrombosis.

The author's indications for arteriography in abdominal and peripheral arteries include: (1) occlusion of large arteries by obliterative arteritis or embolism; (2) aneurysm or arteriovenous fistula; (3) adrenal or renal disease, including tumors and vascular abnormalities; (4) traumatic rupture of arteries; (5) placenta praevia; (6) occasional large abdominal masses not otherwise delineated; (7) rectal disease requiring radical surgery in which vital collaterals supplying the lower extremity (already deficient in blood supply from peripheral vascular disease) may be sacrificed.

The author concludes that arteriography should not be considered a routine practice but should be employed after simpler methods have failed to afford sufficient information as to the pathology, and only when surgical indications are present and proper facilities are available to prevent, as well as treat, serious complications.

One roentgenogram, 3 photographs; 1 diagram.

JOHN P. FOTOPoulos, M.D.
Hartford, Conn.

THE DIGESTIVE TRACT

A Cineradiographic Study of Bottle Feeding. G. M. Ardran, F. H. Kemp, and J. Lind. *Brit. J. Radiol.* 31: 11-22, January 1958. (G. M. A., Nuffield Institute for Medical Research, Oxford, England)

Cineradiographic films at 25 frames per second were taken with a Philips image intensifier of babies feeding from a bottle containing barium suspension mixed with milk. The total duration of each film was limited to approximately four seconds, the dose rate at the skin being about 0.3 r per 100 frames; only two films were taken of each subject. Fifteen English babies, aged six weeks to six months, and 20 Swedish babies, one hour to ten days old, were examined. A study of lambs and kids taking a mixture of milk and barium from a bottle was also made.

The authors conclude from this study that the various types of teat supplied for feeding babies were comparatively ineffective when compared with the soft veterinary rubber teats used for the animals; the performance of the babies was thus not so good as that of the lambs or kids. Other conclusions were:

(1) The influence of gravity is important in bottle feeding. It ensures that the bulb of the teat fills. If the hole in the teat is large enough, milk drips into the mouth; when rigid teats are used, this may be the only way the child can obtain an adequate supply of milk.

(2) The lambs and kids take one teat full of milk with each jaw and tongue movement; the neck of the teat is completely occluded by approximation of the

jaws and the contents of the bulb are expressed into the mouth by elevation of the tongue toward the soft palate, the tongue indenting the bulb from before backwards. Babies usually attempt this movement but in most instances are only partly successful; the teats normally supplied are too rigid and the hole is too small.

(3) Following compression of the bulb of the teat by the squeezing action of the tongue, the lowering of the jaw and tongue must cause some degree of suction which may aid in the refilling of the bulb and it may also draw milk into the mouth; the amount of milk obtained in this manner may in favorable circumstances equal the amount obtained by expression.

(4) During the phase of compression of the bulb of the teat by elevation of the tongue in the forepart of the mouth there is taking place simultaneously a lowering of the tongue behind the teat which must cause suction.

(5) When milk is swallowed, nasopharyngeal closure is made by elevation of the soft palate against the adenoidal pad on the roof of the epipharynx, the mode of closure differing from that seen in adults. The relevant variations in anatomy between infants and adults are discussed.

(6) The bolus passes through the pharynx on both sides of the superior laryngeal aperture. The larynx is closed as each bolus is expressed from the pharynx and reopened just before the next bolus enters. The theory that young babies and members of the herbivora are able to continue feeding by passing food down into the esophagus on either side of the laryngeal aperture without closing the airway is disproved.

Sixty-six roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

Epiphrenic Diverticula of the Esophagus. S. A. Kaufman. *Am. J. Digest. Dis.* 3: 38-44, January 1958. (Massachusetts Memorial Hospitals, Boston, Mass.)

Epiphrenic diverticula, found in the distal esophagus, are thought to be of the pulsion type, though a fragmented muscle layer is present in the wall whereas in a true pulsion diverticulum the wall is composed only of mucosa. It is postulated that a congenitally weak muscle layer allows herniation of the mucosa, which carries with it remnants of the weakened muscle layer.

Symptoms are apparently related to the size and state of the diverticulum and progress as it enlarges. Dysphagia, epigastric pain or soreness, vomiting, hematemesis, and pulmonary complaints have all been recorded. The diagnosis is made almost exclusively by roentgen examination. The lesion presents as an anterior sac-like protrusion just above the cardia projecting to either right or left. It may be the size of a bean or large enough to be confused with an encapsulated hydropneumothorax. Because of rapid emptying, the lesion must be looked for during fluoroscopy.

An epiphrenic diverticulum is most commonly confused with a hiatus hernia. Other lesions to be differentiated are dilatation of the lower esophagus from stricture or achalasia, and diverticulum of the cardiac portion of the stomach. Esophagoscopy reveals intact mucosa leading into the diverticulum. The esophagus distal to the diverticulum should be examined to rule out associated disease.

Complications are not uncommon. Infection, ulceration, hemorrhage, perforation, malignant change, esophagobronchial fistula, and chronic pulmonary infection have been reported.

There is no unanimity of opinion regarding treatment. It is generally accepted that asymptomatic lesions should be left untreated, while symptomatic lesions that do not respond to conservative therapy should be removed. Most authors advocate a simple excision of the diverticulum through a transthoracic approach. Eight roentgenograms.

ROBERT S. ORMOND, M.D.
Dearborn, Mich.

Duplication of the Gastro-intestinal Tract as Part of a New Syndrome of the Neurenterochordal Adhesion and Its Diagnosis. Rudolf Linc and Josef Slanina. *Radiol. clin. 27*: 16-19, January 1958. (In English) (Charles University, Prague, Czechoslovakia.)

The authors describe a case of duplication of the colon, with clinical and radiological findings and post-mortem proof. The tubular structure ended proximally with a fibrous stripe toward the spine.

It is suggested that the cause of all duplications is adhesion of the neuroectodermal layer to the endodermal layer, or of endoderm to the notochord, in the presomitic stage; hence, the new syndrome of "neurenterochordal adhesion." This results not only in intestinal duplication but also in a wide variety of vertebral anomalies ranging from a change in the number of vertebrae to anterior rachischisis. Central nervous system defects, such as hydrocephaly or spastic paralysis, may be associated.

The radiologist should be on the lookout for intestinal duplication whenever he finds anomalies in the spine or central nervous system.

Two roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Retrograde Jejunal Invagination into the Resected Stomach. Giovanni Giordano. *Radiol. clin. 27*: 1-15, January 1958. (In Italian) (Istituto Radiologia-Ospedali ed Ospizi, Lucania, Italy.)

Retrograde invagination of the jejunum into the stomach following partial or subtotal resection is a rare event. It must be considered in any patient who has undergone gastric resection and presents a painful abdominal syndrome with vomiting. In certain cases it may be almost without symptoms, or it may resolve spontaneously, only to recur. The diagnosis is exclusively radiological; the demonstration of the filling defect characterized by the valvulae conniventes within the stomach. Gastrosocopy may succeed in establishing the diagnosis when the roentgen method fails. Early diagnosis allows definitive, early surgical therapy.

The author describes a case diagnosed radiologically in a patient who had had a subtotal gastrectomy for duodenal ulcer three years previously. The operation disclosed a peptic ulcer in the afferent loop as well as the invagination. The ulcer was probably a factor in the invagination. This is the fifteenth such case described in the literature.

Three roentgenograms; 1 diagram.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Heterotopic Pancreatic Tissue Involving the Stomach.

Nestor S. Martinez, Carl G. Morlock, Malcolm B. Dockerty, John M. Waugh, and Harry M. Weber. *Ann. Surg. 147*: 1-12, January 1958. (Mayo Clinic and Mayo Foundation, Rochester, Minn.)

The term heterotopic pancreatic tissue designates the presence of one or more of the histologic elements identifiable as pancreatic tissue outside the boundaries of the pancreatic gland. This study is confined to heterotopic pancreatic tissue limited to the gastric wall. A total of 51 such cases is reported. The mass of pancreatic tissue is usually single, and located within 5 cm. of the pyloric sphincter, usually in the submucosa. Intramuscular and subserosal location is next in order of frequency.

Radiographically the submucosal lesions present a well circumscribed filling defect in the antrum, usually less than 1.5 cm. in diameter, often with a dimple in its center. These lesions should be differentiated from submucous neoplasms with central ulceration, such as leiomyoma and leiomyosarcoma. The latter are larger than pancreatic masses and the ulcer is bigger.

Of the authors' 51 patients, 28 were symptomatic. Symptoms are not specific and resemble those of duodenal ulcer or gallbladder disease. Infrequently pyloric obstruction is produced by intermittent prolapse of the lesion through the pylorus or by proliferation of the surrounding muscle. Severe bleeding occasionally occurs because of ulceration of the overlying gastric mucosa.

The pancreatic tissue is susceptible to the usual pathologic changes, such as myomatous proliferation, ulceration, neoplastic changes, pancreatitis, and formation of cysts. One lesion was found to be islet-cell adenoma.

The demonstration of heterotopic pancreatic tissue in the stomach justifies surgical excision to confirm the nature of the lesion and obviate development of clinical manifestations or pathologic changes.

Three roentgenograms; 2 photomicrographs; 3 photographs; 1 table.

J. S. ARAJ, M.D.
Toledo, Ohio

Study with the Grid in Roentgen Diagnosis of Acute Intestinal Obstruction. Jan Rezek. *Radiol. clin. 27*: 46-53, January 1958. (In German) (Radiologische Klinik der Charles University, Všeobecná nemocnice 1, Prague 2, Czechoslovakia.)

The authors ingeniously project a grid upon a large film of the abdomen, dividing it into small fields within which the movements of the different parts of the intestine can be easily seen and compared with an examination made twenty to sixty seconds later.

Five cases are reported to demonstrate the value of the method in helping to solve the sometimes difficult problem of differentiating paralytic from dynamic ileus.

Ten roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

The Clinical Patterns of Small-Bowel Tumors: A Study of 32 Cases. James F. Patterson, Allan D. Callow, and Alice Rittinger. *Ann. Int. Med. 48*: 123-138, January 1958. (J. F. P., New England Center Hospital, Boston 11, Mass.)

A study was made of 32 cases proved at operation or necropsy to be primary tumors of the small bowel,

which had clearly caused symptoms or signs. Cases were excluded where the tumor was an incidental finding, or where the primary site was the ampulla of Vater or organs other than the small bowel.

It is evident that adenocarcinomas are more common in the upper part of the small intestine, whereas sarcomas are more common in the ileum. Three of the 5 tumors listed as lymphosarcoma were classified by the pathologist as reticulum-cell sarcoma, 1 as malignant lymphoma, and the fifth simply as lymphosarcoma.

Most patients displayed one of two clinical patterns. The first, which the authors have labeled obstruction, occurred in 14 cases and was characterized by a history of recurrent attacks of crampy, midabdominal pain, often with nausea and vomiting. The other, which occurred in 12 cases, was that of blood loss. These patients usually complained of weakness and were often known to have been anemic. Seven of the 12 patients in this category had melena. The five patients in this group who had malignant neoplasms seemed to have steady and less severe bleeding.

The remainder of the patients showed a variety of clinical patterns. Three had constant abdominal or thoracic pain unlike the crampy pain in the obstruction group. In addition, weight loss of over 10 pounds occurred in all but 6 of the 27 patients with malignant tumors, but in none of the 5 with benign lesions.

Four patients had unusual features in association with their small bowel tumors. The syndrome of intestinal polyposis and melanin spots on the oral mucosa, lips, and digits was present in 1 case. One large polyp which histologically was a polypoid adenocarcinoma caused an intussusception which required emergency operation and resection. In 2 cases, the tumors were histologically sarcomas.

Abnormalities in the physical examination were few except for the patients seen during acute small-bowel obstruction. An abdominal mass was felt in only 7 of the 32 patients. Enlarged peripheral lymph nodes were not found in any patient, and the spleen was palpable in only 1.

Tumors of the small intestine may present roentgen abnormalities demonstrable by plain film or contrast studies. In 30 cases plain films were available for review. Multiple dilated intestinal loops indicated small-bowel obstruction in two of these.

Contrast studies with barium were done on 29 patients. Suspected small-bowel obstruction does not contraindicate this kind of study. In 11 cases, a routine gastrointestinal series, including a follow-up film, usually taken ninety minutes later, demonstrated the tumor. Three were located in the duodenum. In 3 additional patients, the tumor was located high in the jejunum.

Five of the tumors were discovered with a complete small-bowel roentgen examination. Additional techniques, such as small-bowel enema or injection of barium through an intestinal tube at the site of obstruction, were used only occasionally to confirm the presence of tumors seen by simpler methods.

The roentgen patterns of small-bowel tumors are characteristic. The alterations resemble those produced by tumors in the colon: polypoid masses, a nodular ulcerated pattern with narrowing of the lumen, widening of the lumen if the tumor develops extraluminally and tends to be necrotic, or annular constricting

deformities. Single lesions of lymphosarcoma may be indistinguishable from adenocarcinoma. Benign lesions may appear as soft, polypoid, intraluminal masses or broad-based filling defects. Intussusception may occur with either a malignant or benign neoplasm.

There were 27 patients with malignant tumors in this series. The lesion was seen in 15 of the 24 patients examined with contrast studies, and suspected because of obstruction in 2 others. In 7, therefore, the diagnosis was missed. In 3 of these, no small intestinal studies were done.

At operation (or autopsy, in the cases where an operation was not performed) there was evidence of metastases (local or distant) in 15 of the 27 patients with malignant tumors.

None of the patients with adenocarcinoma and metastases at operation survived more than twelve months. Of the 7 patients with localized adenocarcinomas, 2 died without operation, 3 survived five years or more, and 2 of these were alive seven years after operation. Seven of 8 patients with sarcoma were alive at the time of the report or survived more than five years.

Five roentgenograms; 3 tables.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Congenital Bilobed Gallbladder. Raymond E. Anderson and Weldon T. Ross. *Arch. Surg.* 76:7-12, January 1958. (R. E. A., General Clinic & Hospital, McMinnville, Ore.)

Duplication of the gallbladder is a rare congenital anomaly in man, although in the lower animals it occurs not infrequently. The malformation may be the result of failure of refusion of the paired buds of the gallbladder primordium or the incomplete recavitation of the embryonic structure early in fetal life. Sixty-four cases of gallbladder duplication have been recorded; 8 of these have been of the bilobed or divided type—a single cystic duct merging into a structure with two distinct fundic chambers. The authors report another case of this type.

The patient was a 54-year-old woman, with a history of epigastric and right upper quadrant pain of several years duration. Oral cholecystography revealed a functioning gallbladder, divided into lobes by what appeared to be a septal partition, with no visible stones. Intravenous cholecystography a few months later again demonstrated a double gallbladder, with a single cystic duct. Since the patient continued to complain of severe indigestion, right upper quadrant pain, and nausea, surgery was carried out. Gross examination showed the cystic duct to be unusually long, measuring 3.5 cm. to its junction with the corpus. The gallbladder was found to contain a longitudinal fibrous septum, which divided it into two lobes of slightly unequal size for about 90 per cent of its length. Each compartment was completely lined by mucosa, which had the appearance of a chronic inflammatory reaction.

While no definite symptoms can be attributed to duplication of the gallbladder itself, the authors believe that the incidence of inflammatory disease is probably higher in this anomaly than in the normally developed structure.

Two roentgenograms; 2 drawings; 1 photograph.

Cholecystitis Cystica and Related Lesions. H. M. Goldberg and M. C. H. Dodgson. *Brit. J. Surg.* 45: 374-378, January 1958. (Manchester Victoria Memorial Jewish Hospital, Manchester, England)

Cholecystitis glandularis proliferans cystica, sometimes called adenomyoma or adenoma of the gallbladder, seems to be related to the better known Rokitsky-Aschoff sinuses, or sequestered, dilated mucosal acini. The process can be recognized at surgery when a firm nodule is felt in the gallbladder wall, usually at the apex or fundus of the organ. Cholelithiasis may or may not be associated, but inflammatory disease is almost always present. Short summaries of 5 representative cases are given, in all of which symptoms were suggestive of cholecystitis.

A related lesion is a narrow-necked fundal diverticulum which can be demonstrated in most cases by cholecystography or cholangiography if obstructive lesions are not present in the biliary system. On excision, the diverticulum will frequently show the proliferative acinar lesions described for cholecystitis cystica. The authors feel that demonstration of the diverticulum indicates disordered biliary function. Three brief illustrative cases are presented.

Either of the two lesions is thought to result from disordered function of the gallbladder, usually with increased intracystic pressure and superimposed inflammatory changes. Increased intracystic pressure may be due to biliary obstruction from stone, tumor, or narrowing of the sphincter of Oddi. The development of the fundal nodule may precede any other evidence of gallbladder disease. Expansion of Rokitsky-Aschoff sinuses may be the basic explanation.

In 64 consecutive cholecystectomies performed by the authors, 16 showed one of the two lesions described above. Essential features of these cases are presented in tabular form.

It is concluded that "the presence of gallstones, of a radiologically visible diverticulum, or of a palpable gallbladder diverticulum or fundal nodule at laparotomy, are findings each of approximately equal value in the diagnosis of biliary dysfunction. Where a fundal lesion is encountered, possible causes of rise in intracystic pressure should be sought and corrected, in order to avoid the occurrence of postcholecystectomy symptoms."

Three roentgenograms; 2 photomicrographs; 1 diagram; 1 table.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Acute Cholecystitis Due to Gas-Producing Organisms. W. A. Wilson. *Brit. J. Surg.* 45: 333-337, January 1958. (Warrington, England)

The literature on emphysematous cholecystitis is reviewed, and an extensive table is presented indicating various clinical, surgical, and radiological features of 26 cases previously reported. The author also reports 1 personal case with fairly typical clinical and radiologic findings.

Although most patients with emphysematous cholecystitis present clinical findings generally similar to those of acute cholecystitis of the more common type, there are a few features of difference. In the reported cases the average age at onset was fifty-six years and the ratio of males to females was five to one, in contradistinction to the findings in the usual type. Approximately one-fourth of the patients were diabetics.

Patients tend to be more toxic and sicker than those with the usual form of cholecystitis.

Radiologic findings are frequently quite pathognomonic. The gallbladder is usually filled with gas and frequently small gas bubbles may be demonstrated in the surrounding tissues. A fluid level in the gallbladder is frequently seen. Differential diagnosis must rule out intestinal biliary fistula, incompetent sphincter of Oddi with reflux of duodenal gas in the biliary system, and postoperative changes in the biliary anatomy allowing entrance of intestinal gas. Ordinarily these conditions can be recognized by the history and physical findings.

The etiology of the disease is not entirely clear but it is evident that the causative organisms are almost always clostridial, most frequently *Cl. welchii*. The author theorizes that emphysematous cholecystitis is an extension of the usual form of cholecystitis in which the blood supply of part of the gallbladder wall has become impaired so that mucosal necrosis occurs, followed by invasion and flourishing of the already present clostridial organisms.

A note as to proper treatment is made. Ordinarily conservative management with antibiotics and supportive therapy is the wisest course, although in some instances the attending physician will choose operative intervention. The prognosis is quite favorable with conservative management and moderately favorable with surgery.

One roentgenogram; 1 table.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Differential Diagnosis in the Examination of the Biliary Ducts after Cholecystectomy. Rolf Köhler. *Acta radiol.* 49: 42-48, January 1958. (Roentgen-diagnostic Department, Surgical University Hospital, Helsinki, Finland)

Seventy-six patients were examined by cholegraphy following cholecystectomy and 30 by postoperative cholangiography to elucidate the problem of accumulations of contrast medium outside the large bile ducts. Cholangiography seems to be of particular value for such an investigation because, in comparison with cholegraphy, the duodenum is better filled with the medium and the amount of contrast material is known. Cholegraphy was also done in 28 unoperated cases.

All examinations were performed with the patient's left side elevated approximately 20° to avoid superimposition of the common bile duct on the spine. Forty cubic centimeters of 20 per cent Biligrafin (Cholografin) was injected through a T-tube.

In only 4 cases was a cystic duct remnant demonstrated, while in 52 cases contrast medium accumulations outside the large bile ducts were seen. In this latter group a rounded well defined accumulation of contrast material appeared laterally near the common bile duct and was shown to lie in the first part of the duodenum. Cystic duct remnants have another appearance. Only large dilated remnants may simulate a contrast-filled duodenal bulb. The occurrence of a cystic duct remnant is dependent on the operative method. If there is any doubt as to the diagnosis, a barium-meal examination is indicated.

Four roentgenograms; 1 table. C. A. REID, M.D.
St. Vincent's Hospital, New York

THE SPLEEN

Calcified Pseudocyst of the Spleen. George F. Asbury. *Arch. Surg.* 76: 148-150, January 1958. (205 Medical-Dental Bldg., Bremerton, Wash.)

Splenic cysts have been classified as dermoid, parasitic, and nonparasitic. Dermoid cysts of the spleen resemble dermoids elsewhere and are rare. Parasitic cysts arise from involvement of the spleen in echinococcosis. Nonparasitic cysts are true cysts or pseudocysts, depending upon the presence or absence of a true epithelial lining.

A case of a large, solitary, calcified pseudocyst in a 33-year-old woman is reported. The patient complained of irregular spells of upper abdominal discomfort, nausea, and vomiting of three months duration, with a loss of weight of 25 lb. Diabetes mellitus had been present since the age of twenty-one. A calcified mass had been discovered in the left upper quadrant eight years previously, during fluoroscopy of the chest for an unrelated condition.

Roentgen examination revealed a round calcified mass high in the left upper quadrant. A barium meal showed displacement of the stomach downward and to the right. No intrinsic lesion of the stomach or duodenum was demonstrated.

After the diabetes had been brought under control, the spleen was excised and found to contain a large cystic mass. The pathologic diagnosis was "calcified pseudocyst of the spleen, probably old peripherally organized hematoma."

The possibility of splenic cyst should be kept in mind in the diagnosis of calcified lesions in the left upper abdominal quadrant.

Three roentgenograms; 2 photographs.

THE MUSCULOSKELETAL SYSTEM

Osteochondrodystrophy (Morquio-Brailsford Type). Occurrence in Three Siblings. Roy Smith and James J. McCort. *California Med.* 88: 55-59, January 1958. (Santa Clara County Hospital, San Jose, Calif.)

Three cases occurring in Japanese brothers, 2 of whom were nonidentical twins, are reported. The parents and four siblings were normal. The patients—fourteen-year-old twins and a nineteen-year-old brother—were dwarfs, each with a short neck, flat nose, dorsalkyphosis, horizontal sternum, coxa vara, genu valgum, and pes planus. They had a characteristic waddling gait. Intelligence was unimpaired. Radiographically widespread disturbance of normal epiphyseal development was seen, with flattened vertebral bodies, secondary subluxations of the hips, and associated degenerative arthritis. Generalized bony demineralization was attributed to disuse atrophy and muscular weakness.

A brief discussion of the differential diagnosis of conditions which are characterized by abnormal epiphyseal development leading to dwarfism is presented and organized in relation to endocrine, metabolic, and developmental factors. These conditions include hypothyroidism, hypopituitarism, rickets (endogenous and exogenous), multiple epiphyseal dysplasia, achondroplasia, gargoylism, and stippled epiphyses. The authors believe that Morquio-Brailsford disease and multiple epiphyseal dysplasia show overlapping clinical and radiological manifestations differing only in degree and extent. It is therefore possible that both diseases represent variations of the same entity, i.e., a disturbance

of epiphyseal development that is inherited and familial. Six roentgenograms; 6 photographs.

LAWRENCE A. POST, M.D.
University of California, S. F.

Congenital Indifference to Pain. L. J. Sandell. *J. Fac. Radiologists* 9: 50-56, January 1958. (Croydon Hospital Group, Croydon, England)

The author describes and discusses the changes which may be seen radiographically in the bones and joints of children who show "congenital indifference to pain." In this condition there appears to be some neurological defect which makes it impossible for the child to distinguish painful and therefore harmful stimuli from the ever-present tactile stimuli which cause no harm. He can feel, but he does not feel pain.

Six cases are described, including the radiological findings. These are as follows:

1. *Osteochondritis or aseptic necrosis* is seen most commonly in the talus, but occurs also in the metatarsals, phalanges, tibial, and femoral epiphyses, and possibly in the elbow joint. The osteochondritis is usually multiple.

2. *Untreated Fractures.* Fractures occurring in small bones may escape notice and remain untreated for some time, with widening of the fracture line and sclerosis of its margins.

3. *Subluxation.* Repeated trauma causes necrosis and destruction of the subchondral bone with resulting deformity of the articular surface and increase of joint space. This, in turn, causes increased mobility, and subluxation occurs.

4. *Hydrarthrosis* is concomitant with subluxation.

5. *New bone formation* occurs around joints from periosteal damage or as a result of a regeneration of bone architecture, or in widening of the epiphysis, juxta-epiphyseal diaphysis, or shaft.

6. *Necrosis of distal phalanges* is almost certainly the direct result of persistent cutaneous infections in the fingers, leading to necrosis and absorption of the terminal and some middle phalanges.

Seventeen roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

Radiological Changes in Reiter's Syndrome and Arthritis Associated with Urethritis. R. S. Murray, J. K. Oates, and A. C. Young. *J. Fac. Radiologists* 9: 37-43, January 1958. (London Hospital, London, England)

The authors discuss the radiographic changes occurring in Reiter's syndrome (nongonococcal urethritis, polyarthritis, conjunctivitis) and point out the similarity of these changes to those seen in rheumatoid arthritis and in some cases of ankylosing spondylitis. Their observations are based on a series of 53 patients.

Characteristic radiographic changes were most commonly detected in the bones and joints of the feet and ankles, the hands and wrists, and the sacroiliac joints. In 6 cases typical changes of ankylosing spondylitis were found in the lumbar spine and sacroiliac joints.

The changes found are classified as follows:

1. *Simple fusiform thickening of the periarticular tissues* was most commonly seen in the interphalangeal joints of the fingers.

2. *Osteoporosis.* In several cases the radiographic

appearance suggested osteoporosis, though this was not as marked as it sometimes is in rheumatoid arthritis.

3. *Destructive lesions*, conveniently described as erosions, were seen in all the joints showing radiographic changes, but were most easily recognized in the small joints of the hands and feet.

4. *Joint-space Changes*. Destruction of articular cartilage with narrowing of joint-spaces almost invariably accompanied erosions, progressing in many cases to disorganization and subluxation at the joint concerned, especially in the metatarsophalangeal and interphalangeal joints of the feet.

5. *Periosteal new-bone formation* was a striking feature in many cases, affecting the short bones, such as the metacarpals, the long bones of the forearm and leg, the tarsus and carpus, and the pelvis.

6. *Deformities*. Flattening of the longitudinal and transverse arches of the feet was seen in several patients. It was usually associated with hyperextension of the metatarsophalangeal joints and hyperflexion of the proximal interphalangeal joints.

It appears that previous descriptions of peripheral joint changes associated with ankylosing spondylitis are closely similar to those of Reiter's syndrome. The type of change and distribution of the lesions seen in this syndrome so much resemble those of rheumatoid arthritis that radiographic appearances alone cannot be relied upon to differentiate these conditions. It would seem that the diagnosis of rheumatoid arthritis in the male should be reviewed and, if there are any atypical features, the possibility of Reiter's syndrome should be considered and evidence of genitourinary infection diligently sought.

Fifteen roentgenograms; 1 table.

THEODORE E. KEATS, M.D.
University of Missouri

Radiological Aspects of Reiter's Syndrome ('Venereal' Arthritis). D. F. Reynolds and G. W. Csonka. J. Fac. Radiologists 9: 44-49, January 1958. (D. F. R., St. Mary's Hospital, Paddington, London, England)

The authors studied 185 patients with arthritis associated with urethritis (Reiter's syndrome). All but 2 were males. Films of 60 cases were investigated for evidence which might suggest the diagnosis. Twenty-five cases showed arthritis only, apart from the genital infection, and in 35 there were additional changes, especially in the eyes and skin. The same radiologic changes occurred in both sets of patients.

Rheumatoid arthritis presented the major diagnostic difficulty and some of the differential diagnostic points are outlined. Chronic sacroiliitis was diagnosed in 16 patients and confirmed radiologically in 11.

It was found that certain recurring radiological features in patients with polyarthritis, though usually seen in rheumatoid arthritis, should arouse suspicion of a possible underlying urethritis in males. These are: edema of the tendon of Achilles or patellar tendons; periosteal new bone formation adjacent to a metatarsophalangeal joint; active bone deposition or erosion of the plantar aspect of the os calcis due to plantar fasciitis; "rheumatoid arthritis" in a male, with the feet more seriously affected than the hands; sacroiliitis preceded by peripheral arthritis and without significant spinal involvement.

Twenty-seven roentgenograms; 2 tables.

THEODORE E. KEATS, M.D.
University of Missouri

Osteosclerosis in Chronic Renal Disease. Horace L. Wolf and John V. Denko. Am. J. M. Sc. 235: 33-42, January 1958. (Northwest Texas Hospital, Amarillo, Texas)

Seven cases are reported of chronic renal disease in which varying degrees of osteosclerosis developed. The sclerosis began in the cortex and extended into the marrow portions. The lumbar vertebrae were involved in all cases and the pelvis, thoracic cage, sacrum, skull, and femurs in some. The authors suggest that these changes are "probably related to renal metabolic acidosis."

Two roentgenograms; 5 photomicrographs; 3 tables.

HOWARD J. BARNHARD, M.D.
University of Arkansas Medical Center

Multiple Myeloma. Robert Knox Memorial Lecture. E. Rohan Williams. J. Fac. Radiologists 9: 2-12, January 1958. (Radiological Department, St. Mary's Hospital, London, England)

This discussion of multiple myeloma was delivered before the British Faculty of Radiologists on April 12, 1957.

The radiologist is not infrequently the first person in a position to suggest the diagnosis of multiple myeloma. The author points out that in many cases of this disease the radiologic changes differ markedly from the classic descriptions of multiple rounded, well defined osteolytic foci, varying, instead, from ill defined granular or cyst-like diffuse osteoporosis to an apparently single osteolytic lesion, which may be of considerable size when first observed.

The disease is dominantly one of the fifth, sixth, and seventh decades of life. The cardinal features are pain, tumor formation, deformity, and pathological fractures, but cases are sometimes seen in which the skeletal manifestations have been minimal until the late stages, and the outstanding features have been severe anemia or renal insufficiency, either of which may lead to cardiac failure.

The principal symptom in multiple myeloma is skeletal pain. The pain is most commonly in the lower part of the back and in the chest wall and sternal region. Pathological fractures are common. The vertebral bodies and the ribs are dominantly affected. A sternal fracture is a serious complication, especially if vertebral collapse and kyphosis are present in the dorsal spine. Palpable tumors are often present and occasionally tumor formation is the presenting symptom. An interesting feature is that an individual tumor may vary in size from time to time, even without treatment. Deformities are peculiarly thoracic, with kyphosis in the mid or lower dorsal spine and angulation of the sternum. The posture is characteristic, with the abdomen protruding, the lower ribs abutting on the iliac crests, and the chin sunken on the chest. The patient adopts a wide stance, and walks with infinite care.

Many patients with multiple myeloma suffer intermittently from bronchitis and recurrent attacks of pneumonia. The high serum protein may well be associated with increased blood viscosity, commonly leading to a proneness to pulmonary infection.

Signs and symptoms referable to the central nervous system are not uncommon and a high proportion of cases show severe renal functional impairment. Although the blood-urea nitrogen may be high, hypertension is rare.

There are two broad and differing patterns of skeletal involvement. The commoner form can be truly termed myelomatosis, in which there are widespread multifocal sites of bone destruction. In these cases sternal or iliac marrow puncture will invariably show the plasma or myeloma cells dominating the cellular field under microscopic survey. The less common form is that in which initially there are either apparently single or several widely scattered osteolytic foci, most bones showing normal appearances. In these cases, sternal marrow puncture may well be negative for myeloma plasma cells. This pattern may remain for months or years, but ultimately generalized myelomatosis will usually ensue.

Abnormal protein metabolism is present, manifested by Bence Jones proteinuria, hyperglobulinemia, and primary amyloidosis or paramyloidosis.

The radiologic appearances can be grouped in three main categories.

1. *Multiple rounded zones of complete bone destruction* with either sharp or moderately clear-cut margins and no demonstrable new bone formation. Such changes are best seen in the skull, pelvis, ribs, and clavicles, and sometimes in the long bones of the limbs. The osteolytic foci may coalesce, leading to large areas of bone loss with abrupt, scalloped, and curvilinear margins.

2. *Single zonal areas of bone destruction* tending to be larger than the lesions in Group 1. Such areas may be found in a vertebral body leading to collapse, occasionally in a long bone, particularly in the iliac bones of the pelvis, and in the sacrum. Again there is no reactive new bone formation. One may state dogmatically that, if there is any sclerotic reaction at the margin of an osteolytic focus, this is not due to a plasmacytoma or myeloma.

3. The appearances leading to the greatest difficulties in interpretations are of two types. The first is a *widespread patternless osteoporosis*, the bones showing a ghostly appearance. This is especially apt to be found in the spine and to be associated with collapse of vertebral bodies. Secondly, there is a *diffuse granular osteoporosis*, in which multiple vertebral collapse is initially uncommon.

Pathological fractures, as pointed out above, are common. Callus formation circumferentially is seldom impaired, but direct repair between the fracture surfaces is rarely found.

The author calls attention to one very characteristic picture of multiple myeloma—almost a pathognomonic finding. In chest films, multiple ill-defined soft-tissue opacities with curvilinear margins can sometimes be seen encroaching on the lung fields. Coincident with each of these, there will occur a zone of rib destruction, with or without a pathological fracture.

When a long bone is involved, there is a tendency for multiple foci to be grouped together in one part of the bone, the remainder of the bone showing little or no change.

It is stressed that myelomatosis may be very extensive, as shown postmortem, with remarkably little obvious skeletal change in the radiographs.

Cases are presented to illustrate the statements made above.

Twenty-five figures, including 21 roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

Four Cases of Myelomatosis. R. W. McNabb. J. Fac. Radiologists 9: 13-15, January 1958. (Edgware General Hospital, Edgware, England)

Four cases are presented to illustrate the varied radiological manifestations of myelomatosis and the difficulty of diagnosis.

The first patient, aged 64, had a lesion in the clavicle radiographically resembling an osteoclastoma. The author emphasizes the point that an osteoclastoma is usually found in the third decade, and is rare after forty. It is also interesting that the patient stated that a "lump" had been present for many years, indicating that this case would fit with the group of myelomas which are solitary at onset and subsequently show diffuse spread.

The second case emphasizes the difficulty of differentiating vertebral collapse, especially in an age-group with varying degrees of osteoporosis. In this case, the initial film showed slight cortical destruction and a spotty appearance of the vertebral body, which helped to give a diagnosis of neoplastic change rather than osteoporosis.

The third case exemplifies one of the two forms of plasmacytoma which is either (1) like osteoclastoma or (2) purely osteolytic. A roentgenogram of the hip showed an area of cortical destruction and rarefaction medial to the left acetabulum. The lesion was solitary, but the generally accepted opinion is that even after a period of years an apparently solitary lesion can become multiple.

The fourth case shows striking features which presented immediately on the chest radiograph as a tumor projecting into the lung field on the left. This led the way to closer investigation and the finding of rib changes indicating myeloma.

Five roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

Central (Medullary) Fibrosarcoma of Bone. W. Scott Gilmer, Jr., and G. Dean MacEwen. J. Bone & Joint Surg. 40-A: 121-141, January 1958. (869 Madison Ave., Memphis 3, Tenn.)

A carefully appraised series of 22 cases of intramedullary fibrosarcoma is the subject of this report from the University of Tennessee Medical School. Some authors have indicated that all such lesions are secondary extensions from periosteal and parosteal tumors. The authors, however, believe they are a separate entity. Grossly, radiographically, and clinically there is good evidence that they are of intramedullary origin. While it is perforated by extension in some cases, the cortex in most instances, though thin, is intact.

The radiographic characteristics include: (1) intramedullary origin; (2) lytic, indefinite, moth-eaten margins; (3) marginal sclerosis in lower-grade lesions; (4) periosteal reaction, often present but never marked; (5) frequent failure of films to indicate extent of involvement by tumor.

Survival statistics quoted in the literature on soft-tissue fibrosarcoma (38-81 per cent five-year survivals) cannot be transposed to intramedullary fibrosarcoma. In the authors' group only 26 per cent were cured. A survival of two years without recurrence generally indicates a cure.

These cases must be carefully separated pathologically from chondrosarcoma and osteogenic sarcoma,

which generally have fibrosarcomatous elements. When critically separated, they are seen as a distinct entity pathologically, grossly, and prognostically. The ages in this group of cases ranged from twelve to seventy-one years, the majority of patients being in the second, third, and fourth decades.

Thirteen roentgenograms; 6 photomicrographs; 5 photographs; 1 chart; 1 table.

G. MELVIN STEVENS, M.D.
Palo Alto, Calif.

Cervical Intervertebral-Disc Calcification in Children.

Thomas Hans Newton. *J. Bone & Joint Surg.* 40-A: 107-113, January 1958. (721 Huntington Ave., Boston, Mass.)

Intervertebral disk calcification is relatively uncommon in children. The author reports 7 cases seen over a twelve-year span, in patients between three and ten years of age. Twelve cases were found in the literature. A recent head or neck injury which seemed to initiate the illness was noted in only 6 of the 19 patients. Seven patients had slight to moderate fever, just prior to and during the onset of symptoms. Some of these 7 had associated sore throats. Six had sudden onset of neck symptoms without any preceding illness or obvious injury. All but one of the author's patients had an acute episode of pain in the neck, limitation of motion, and torticollis.

Calcification was demonstrable in all interspaces from the second to the seventh cervical vertebra, the highest incidence being in the lower cervical spine. Three of the patients in the author's group also had calcified material in the prevertebral tissues. The prognosis was favorable in all cases, with rapid regression of the calcification following conservative measures in most of the patients.

It has been suggested that this syndrome may be analogous to calcific tendinitis. It is probably much more common than the few reports in the literature would suggest.

Fourteen roentgenograms.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Dumb-Bell Ganglioneuromata of the Spine with a Report of Four Cases. R. H. Shephard and David Sutton. *Brit. J. Surg.* 45: 305-317, January 1958. (Maida Vale Hospital for Nervous Diseases, London, England)

A comprehensive review of the literature on dumbbell ganglioneuroma of the spine, with a brief summary of each of the previously reported 11 cases is given. To these, 4 new cases are added. These tumors are predominantly dorsal or dorsolumbar. Most cases show onset in infancy or early childhood with symptoms that may persist over many years.

Ganglioneuromas are benign tumors of the sympathetic nervous system. They are to be differentiated from dumbbell neurofibromas, which can occur at any spinal level and are usually found in later life. Most of the patients with dumbbell ganglioneuroma have paraplegia of gradual onset, sometimes with remission of symptoms, but with gradual progression.

Diagnostic features are often clear-cut and quite characteristic on plain roentgenograms. The extra-spinal component of a dumbbell ganglioneuroma, if it lies in the thoracic region, is readily visualized as a mediastinal mass. It may be hidden behind the car-

diac shadow, but usually, unless it is very small, the mass is readily detectable. An abdominal mass is, of course, much less evident and may be palpable before it is demonstrable on the plain radiograph. On the other hand, such a paraspinal abdominal mass may be quite easily visible. Enlargement of intervertebral foramina was present in 3 of the authors' cases and in several of the other cases described, and is readily detectable on the radiographs. Where the tumor extends along the spinal canal, pedicle splaying and pedicle erosion may also be seen.

Myelography will adequately outline the level of the spinal block, and if necessary the upper and lower limits of the tumor can be shown by Myodil injected both from above and from below. Usually the myelogram will show the characteristic appearances of an extramedullary, extradural expanding lesion.

It is important to demonstrate and treat the lesions early in life, before irreversible changes have occurred in the central nervous system.

The main features of the 11 previously reported cases, as well as of the authors' cases, are presented in a comprehensive table.

Fourteen roentgenograms; 7 photomicrographs; 1 photograph; 1 table. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Vertebral Osteoclastoma with Spinal Cord Compression. Norman Whalley. *Brit. J. Surg.* 45: 364-372, January 1958. (Swansea, Wales)

Osteoclastoma is a tumor of osteoclasts in which the functional bias of the cells is lytic rather than blastic. It is always an aggressive and destructive lesion. Other names for the same tumor appear to include myeloma, myeloid sarcoma, and benign giant-cell tumor. The lesion may be easily confused radiographically with the aneurysmal bone cyst described by Lichtenstein but histologically the lesions are very different.

The author presents in tabular form the main features of 33 cases of spinal osteoclastoma he has been able to find in the literature and adds 4 cases of his own. More than half of the cases presented evidence of spinal cord or cauda equina involvement. All of the author's 4 cases showed a striking similarity in clinical, radiological, and surgical features. The patients were in their teens or twenties, with histories of gradual onset of weakness and sensory disturbances in the legs, with or without symptoms referable to the urinary bladder. The lesions were readily demonstrable on plain films of the spine and presented characteristic lytic destructive features. One tumor developed in the high dorsal spine and the other 3 near the lumbodorsal junction. Myelography showed complete block in all instances and tended to outline well the overall extent of the tumors.

Treatment in 3 of the 4 cases was primary surgical removal of as much of the lesion as possible, followed by a course of moderately intensive radiotherapy to the involved site. The fourth case, which presented less severe paralytic features than the others, was treated primarily by radiotherapy following verification of the lesion by biopsy. In all 4 instances a gratifying result was obtained, with essentially complete recovery of function of the weakened legs, recalcification of the lesion in the spine, and apparent inactivation of the tumor.

The author feels that spinal osteoclastoma associated

with compression of the spinal cord can be successfully treated by radiotherapy alone provided the compromise of the spinal cord is not advanced at the time treatment is begun. In the latter event it seems safer to decompress the spinal cord first by laminectomy and then to apply radiotherapy. Although specific radiotherapeutic technics are not outlined, it appears that moderate doses, in the range of 2,000 r in three to four weeks [tumor dose?] followed by a similar course in about three months, are adequate.

Eleven roentgenograms; 1 photomicrograph; 1 table.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Central Fractures of the Acetabulum. Robert A. Knight and Hugh Smith. *J. Bone & Joint Surg.* 40-A: 1-16, January 1958. (869 Madison Ave., Memphis 3, Tenn.)

The authors as a matter of convenience describe the acetabulum in relation to the face of a clock: the 6 o'clock point is at the center of the acetabular notch, the 3 o'clock point is at the posterior margin, and the 9 o'clock point is at the anterior margin. For constancy of nomenclature, the designation is always as if this clock face were superimposed on the left acetabulum. Thus the weight-bearing vault below the anterior inferior spine is at 10 o'clock and extends posteriorly to 3 o'clock. This is the most critical area when reduction of a fracture is attempted.

The authors believe that open reduction of central fractures of the acetabulum is technically feasible, the primary objective being to restore the weight-bearing vault. Though a detailed classification of these fractures is not possible or necessary, a simple working rule divides them into two major types: horizontal and vertical. The horizontal fracture is approached through an anterior incision; the vertical through a posterolateral incision. Stereoscopic anteroposterior radiographs are essential for correct interpretation of the fracture and choice of the approach.

Long term studies of a large series of patients will be necessary for full evaluation of the method, but early results in 8 cases indicate that open reduction generally gives superior results to those obtained in the past by older methods of manipulation and traction.

Twenty-five roentgenograms; 3 diagrams; 1 table.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Femoral Arteriograms: Use to Demonstrate Circulation of the Hip Following Neck Fractures of the Femur. A. E. McGinnis, J. O. Lottes, and Fred C. Reynolds. *Missouri Med.* 55: 31-34, January 1958. (Washington University School of Medicine, St. Louis, Mo.)

Femoral arteriograms were obtained on 12 patients with fracture of the femoral neck; 9 were examined after surgery and 3 before pinning. In 11, arteriograms of the uninjured side were obtained for comparison. The authors' purpose in the study was to obtain information on the circulation about the hip following fracture or its management, and possibly from this to draw a conclusion as to future healing.

Arteriography was done with 35 per cent Urokon and serial films were taken. Vessels within the bone were not demonstrated in any instance and dependence was therefore placed upon visualization of the posterior collum branch of the medial circumflex femoral artery

and the general vascularity in the region of the hip for determining the status of the circulation.

Long follow-up studies for healing of the fracture were possible on 9 patients (nine months to six years). In 1 there was increased generalized vascularity on the arteriogram and healing was good. The remaining 8 showed evidence of decreased flow in the posterior collum branch. One of these had good union, while the other 7 had complications of aseptic necrosis or nonunion, or both.

No conclusions of a prognostic nature based on alteration of the arterial circulation about the hip, following the fracture, can be drawn from this small series. It does suggest, however, that when the circulation appears equal to or greater than in the uninjured hip, the chances are better for union and a viable head.

Six roentgenograms; 1 diagram; 1 table.

J. S. ARAJ, M.D.
Toledo, Ohio

Progressive Diaphyseal Dysplasia (Engelmann's Disease). Report of a Case with Twenty-Two-Year Follow-up. Victor G. Mikity and George Jacobson. *J. Bone & Joint Surg.* 40-A: 206-210, January 1958. (1200 N. State St., Los Angeles 33, Calif.)

The authors report a well documented case of diaphyseal dysplasia first diagnosed in a twenty-nine-year old male. Most of the features of this case were fairly characteristic: bone pain in youth, dense cortical bone producing thickening of the diaphyses, normal marrow and peripheral blood elements, and normal blood chemistry. In contrast to some cases, general physical and muscular development were normal, with no deformities. The patient was followed over a long term, radiographically and clinically, and only minimal evidence of progression of the disease was seen in the distal radii and ulnae. Similar stability of the skeletal manifestations of this disease has been reported by other authors in cases first diagnosed in adulthood.

Seven roentgenograms; 1 photomicrograph; 2 photographs.

G. MELVIN STEVENS, M.D.
Palo Alto, Calif.

THE SPINAL CORD

Multiple Aneurysms of the Spinal Cord. G. Lombardi and M. Bianchi. *Radiol. clin.* 27: 24-28, January 1958. (In Italian) (Istituto neurologico, via Celoria 11, Milan, Italy)

While common elsewhere in the body, aneurysms in the spinal cord are rare. The case reported here is said to be the sixth in the literature.

The patient was a twenty-two-year-old male with a variety of neurological signs and symptoms dating from birth. The aneurysms eroded the adjacent vertebral bodies in the manner of a benign tumor. Myelography suggested intradural, extramedullary masses but offered no suggestion as to their vascular nature, such as pulsations. The diagnosis was made only on operation.

Therapy in this condition is an unsolved problem; vascular ligation would incur the risk of medullary ischemia. In the present patient, surgery was limited to decompressive laminectomy, which partially relieved the patient's complaints.

Two roentgenograms; 2 diagrams.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

GYNECOLOGY AND OBSTETRICS

Arteriovenous Fistulae of the Uterus and Adnexa; an Arteriographic Study. Ulf Borell and Ingmar Fernström. *Acta radiol.* **49**: 1-16, January 1958. (Karolinska Sjukhuset, Stockholm, Sweden)

This study supplements a previous investigation (Borell *et al.*: *Acta radiol.* **44**: 378, 1955. *Abst. in Radiology* **67**: 631, 1956) which demonstrated abnormal arteriovenous communication in 2 cases of hydatidiform mole. The present study shows that arteriovenous fistulae may occur also in cases of miscarriage, missed abortion, and ectopic pregnancy.

Percutaneous retrograde pelvic arteriography was performed on 517 women. Gynecologic disorders were present in 345. The remainder were pregnant. Films were obtained on completing injection of the contrast medium and at two- and four-second intervals afterward. These demonstrated an arterial phase, a capillary phase, and a phase in which no arteries were opacified. Phases were substantiated by serial roentgenography. The presence of an arteriovenous fistula was indicated by venous opacification during the arterial phase. Venous filling after the arterial phase is not indicative of an abnormal arteriovenous communication.

Veins containing contrast material were demonstrated in only 2 gynecologic cases, and in both of these after the arterial phase. Venous filling occurred in 25 per cent of the 172 obstetric cases.

A total of 18 arteriovenous fistulae were found. One fistula appeared in a group of 118 normal pregnancies. Four fistulae were present among 20 miscarriages and missed abortions. Ten fistulae appeared in a group of 35 ectopic pregnancies. Two of 4 patients with hydatidiform mole and 1 with chorionepithelioma had fistulae.

The authors feel that abnormal arteriovenous communication in ectopic pregnancy, miscarriage, missed abortion, and hydatidiform mole is due to necrosis of villi with a resulting shunt from artery to vein. Spontaneous closure of the shunt occurred in 1 case of interstitial pregnancy. In chorionepithelioma, malignant trophoblastic cells probably injure adjacent artery and vein walls to produce the shunt.

Four case reports are included. The findings do not support the view that the normal placenta represents a modified arteriovenous fistula.

Twenty-three roentgenograms; 2 tables.

KENNETH D. DOLAN, M.D.
University of Missouri

THE GENITOURINARY SYSTEM

Selective Angiography in Renal Tuberculosis. J. Frimann-Dahl. *Acta radiol.* **49**: 31-41, January 1958. (Ullevål Hospital, Oslo, Norway.)

The author surveys 23 selective renal angiographic examinations made in preparation for partial resection of tuberculous kidneys.

An opaque catheter is inserted through a needle in the femoral artery. Under fluoroscopic guidance the catheter is placed in the appropriate renal artery. Filming follows injection of 8 ml. of 35 per cent Hypaque. An experienced examiner can complete the examination in one hour. No apparent complications, untoward reactions, or renal damage have appeared in the author's experience.

Pathologic changes produce alterations in the course of main renal vessels and their primary branches. Local pathology may produce alteration in smaller vessels. Parenchymal involvement alters the outline of the kidney.

Small tuberculous foci produce little or no disturbance in the vascular pattern. The earliest changes are small irregularities in one or more arterial branches. These may be pushed apart, bent, curved, blocked, narrowed, or dilated. Calcification, when present, directs attention to the region of vascular abnormality and is an important operative indication. Renal outline irregularities may be helpful in disclosing the site and size of tuberculous foci. Such defects are better delineated in selective angiograms than in aortograms or urograms.

Large tuberculous foci are more conspicuous. Artery branches may be blocked completely giving a nonvascular zone of variable size. This finding is most valuable when calyceal occlusion, without other signs of destruction, is apparent on the urogram. Arteries may run in a claw-like fashion around a cavity or abscess and outline the size of an area of destruction. Parenchymal translucency may be observed, but good bowel preparation is necessary before one can evaluate this feature.

The author found 5 vascular anomalies among his cases. The vessels were accessory or aberrant in position. When the main renal artery is catheterized, opaque material may not be injected into such an anomalous vessel, and the renal area supplied by it will then be unfilled. This unfilled area may be erroneously called a tuberculous focus.

Twenty examinations in the present series were considered good. Three were unsatisfactory. Nineteen selective angiographic examinations were considered better than accompanying aortograms. In comparison to aortography, selective angiography offers two advantages: Superimposed vessels are excluded from the renal area, and coned views may be made with resulting better film quality.

Good demonstration of the renal vascular patterns is of great value to surgeons performing partial kidney resections. Complete correspondence of radiographic appearances and the actual lesion was found surgically in 12 of 17 operated cases.

Eighteen roentgenograms; 4 photographs; 1 table.

KENNETH D. DOLAN, M.D.
University of Missouri

The Extravesical Ectopic Ureter. A. G. Ellerker. *Brit. J. Surg.* **45**: 344-353, January 1958.

A review of the literature indicates that 459 cases of extravesical ectopic ureter have been reported. In the majority of cases the ectopic ureteral orifices drain into some part of the genitourinary tract. In males the commonest site is in the posterior urethra or occasionally into the seminal vesicle or closely adjacent structures. In females the usual site of the ectopic orifice is in the posterior wall of the urethra, the vestibule, or the vagina. Somewhat surprisingly, the diagnosis may not be made until the second or third decade, and not at all infrequently the condition is found only postmortem. Symptoms in males tend to be minimal or absent because the draining ureteral orifice is usually proximal to the external vesical sphincter. In females, however, a lifelong history of incontinence is usual. Symptoms may be aggravated in either sex

by development of the common complications of obstruction, infection, and calculus.

An exact diagnosis may be difficult and will frequently call for meticulous urological study. Only visualization of the orifice coupled with catheterization and dye injection can prove conclusively the presence of the ectopic ureter. Reference to the anomalies of the upper urinary tract known to be associated with ureteral ectopia reveals the necessity of a good pyelogram. The most commonly associated renal anomaly is the presence of a small renal element drained by the ectopic ureter and situated at the upper pole of the kidney. This element, however, has poor or little concentrating power and may be easily missed.

Treatment is always surgical. The majority of cases are best managed by resection of the anomalous renal element with as much of the ectopic ureter as possible. In some cases simple ligation of the ectopic ureter will suffice, but the residual ureter is unusually prone to later infection.

The author reports in moderate detail 6 cases, illustrating the above points.

Eleven roentgenograms; 1 photograph; 2 diagrams; 2 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Intermittent Obstruction at the Ureteropelvic Junction. David Falk. *J. Urol.* 79: 16-20, January 1958. (2026 17th St., Bakersfield, Calif.)

Obstruction at the ureteropelvic junction, although most often constant, may sometimes be intermittent in type. Between attacks of obstruction, the urinary tract may appear entirely normal by all methods of investigation. The answer to the diagnosis lies in instituting pyelographic study, both excretory and retrograde, during an acute attack.

Although an aberrant vessel is the most frequent cause, intrinsic ureteropelvic stenosis can also lead to intermittent obstruction. The exact mechanism of acute block and spontaneous release is not known. In the case of aberrant vessel it is probably positional, and in the instance of intrinsic stenosis, either spasm or edema causes the acute urinary retention.

Undiagnosed intermittent ureteropelvic obstruction may result in progressive renal damage, considerable economic loss to the patient, and perhaps needless surgery of an "exploratory" nature. The taking of a careful history is of primary importance, and diagnosis requires clinical knowledge of this condition combined with healthy suspicion. Treatment is surgical, dependent upon the findings and surgical judgment.

Four cases are presented, 2 of which occurred in children aged five and six.

Ten roentgenograms.

CHARLES M. GREENWALD, M.D.
Iowa City, Iowa

The Problem of Vesicoureteral Reflux in Children. C. M. Pasquier, Jr., E. C. St. Martin, and J. H. Campbell. *J. Urol.* 79: 41-51, January 1958. (C. M. P., 940 Margaret Place, Shreveport, La.)

Gravity and post-voiding cystograms were obtained in the routine work-up of a group of 341 children with pediatric urological problems. Vesicoureteral reflux occurred in 43 or 13 per cent of them. This phenomenon is generally believed to be rarely, if ever, observed in the absence of some other demonstrable urologic disorder.

Reflux appeared in some only when the bladder was filled by gravity, in others only after voiding, and in some on both views. Study as to what part, if any, intravesicular pressure played in the development of reflux produced conflicting and perplexing findings. There appears to be no fixed level at which reflux appears, and in the same patient the relations between pressure and reflux may be inconsistent.

The basic mechanism by which reflux occurs is still not entirely clear. The general opinion is that there is some alteration, structurally, functionally, or both, in the so-called ureterovesical valve. Some experimental evidence suggests that a relatively long intravesical ureter is important in preventing reflux. It is not difficult to understand how alteration in the intravesical segment may occur from obstructions, infections, neurogenic dysfunction of the bladder, and trauma of the intravesical ureter.

The authors' experience would indicate bladder neck obstruction to be the fundamental cause of ureterovesical changes resulting in reflux, this having been found in 58 per cent of the cases in this series. However, following bladder neck resection, the reflux persists in a fairly large percentage of cases, the incidence in this series being 13 of 24 children (54 per cent). That this materially reduces chances for an entirely satisfactory clinical result is seen from the fact that when reflux disappeared after surgery 90 per cent of the children made a complete recovery; when reflux persisted, only 38 per cent could be considered well.

Certain conservative measures for persistent reflux include eradication of infection and frequent voiding during the day, together with restriction of fluid in the evening. The latter measure will be helpful only when reflux occurs as bladder capacity is approached. Triple voiding (see Lattimer *et al.*: *J. Urol.* 76: 656, 1956) has been recommended when the problem is primarily one of post-voiding reflux. However, the authors feel that something more positive must usually be done in this condition.

The Hutch vesicoureteroplasty is discussed and is said to offer a valuable means of counteracting certain cases of persistent reflux. But, although reflux is usually abolished, progressive damage and/or dilatation of the upper urinary tract on the operated side may occur. This was seen in 4 of the authors' 11 surgical cases, 5 of which were in adults. Damage may have been due to technical error and this is not offered as a criticism of the operation, which has a sound basis. The fact that such change can occur following the Hutch operation, however, should temper one's enthusiasm and serve as a note of caution to be judicious in the selection of cases.

An attempt is made to establish such criteria. The Hutch vesicoureteroplasty is to be recommended when simpler forms of therapy have failed. Whether it should be employed at the same time as bladder neck resection is uncertain. Probably the only type justifying the combined procedure is the case showing marked reflux on the post-voiding cystogram. In this series where troublesome reflux persisted following bladder neck resection, it invariably occurred on the post-voiding cystogram. The majority of those patients who made a satisfactory recovery, even though reflux continued, showed this abnormality on the gravity cystogram only.

Thirty-five roentgenograms; 4 cystometograms; 1 chart.

CHARLES M. GREENWALD, M.D.
Iowa City, Iowa

THE ADRENALS

Pheochromocytoma of the Adrenal Gland with Granulosa Cell Tumor and Neurofibromatosis: Report of a Case with Fatal Outcome Following Abdominal Aortography. Joaquin F. Lopez. *Ann. Int. Med.* 48: 187-199, January 1958. (J. F. L., Laboratory Service, VA Center, Milwaukee, Wisc.)

In 1952, Aaron stated that about 300 cases of pheochromocytoma had been published. Seven cases have been reported in association with malignant neoplasia: 4 with neuroblastomas, 1 with a "neurogenic sarcoma," 1 with carcinoma of the rectum, and 1 with a neurofibromatosis with "malignant degeneration." The author reports a case in association with malignant granulosa-cell tumor and neurofibromatosis. This case is of interest also as the second of pheochromocytoma in which death followed abdominal aortography. The mechanism of death appears to be adrenal crisis precipitated by intra-adrenal and/or periadrenal hemorrhage, with liberation of large amounts of pressor substances (adrenalin and noradrenalin). Pressor substances, as determined postmortem, were significantly elevated in both the adrenal tumor and the heart.

Four photomicrographs; 3 photographs; 1 chart.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

MISCELLANEOUS

Sickle-Cell Anæmia. J. H. Middlemiss. *J. Fac. Radiologists* 9: 16-24, January 1958. (Department of Diagnostic Radiology, United Bristol Hospitals, Bristol, England)

The author reviews the radiologic manifestations of sickle-cell anemia. These manifestations are skeletal or visceral.

Skeletal Changes. (1) Changes due to Thrombosis: Infarction in the small bones of the hands and feet is especially common in infancy and early childhood. Periosteal reaction accompanies these changes. As in all cases of aseptic necrosis, osteoclastic resorption of necrotic bone follows, manifest radiologically as a zone of translucency or resorption in the affected bone. In the long bones, changes lag behind the clinical picture, but infarction produces, in due course, characteristic appearances. Here, too, the necrotic bone is removed by osteoclastic resorption, but sometimes some necrotic debris becomes calcified. If the infarct is in the medulla, a central area of radiolucency due to osteoclastic resorption of necrotic trabeculae is seen, with a sclerotic ring around it, due to the local osteoblastic reaction. If the infarct is near the cortex, the local hyperemia will affect the penetrating branches from the periosteum, resulting in periosteal proliferation. If the subarticular zone of a bone end is involved, and use of the joint is continued, the necrotic

bone becomes compressed and loss of the normal contour of the joint surface occurs over a sclerotic area of bone.

(2) Changes due to Hyperplastic Response of the Erythroblastic Elements to the Long-standing Hemolytic Anemia: Increased radiolucency of the skeleton is the most apparent feature, being often due in the long bones to widening of the medullary or intertrabecular spaces associated with thinning of the cortex. The vertebral bodies often show the features of intense osteoporosis or de-ossification. Compression fractures occur and may take the shape of "wedging" or, more characteristically, a bi-concavity with bulging of the nucleus pulposus into the apposing margins of adjacent vertebral bodies.

Skull changes also have some characteristic features. They may take the form of widening of the diploë and there may be thickening of the frontal and parietal bones and thinning of the outer tables with radial arrangement of new trabeculae—the so-called "sun-ray spicule" appearance.

(3) Skeletal Changes due to Disturbance of Growth: If sickle-cell anemia becomes manifest in childhood, disturbances of growth undoubtedly occur. For example, there may be a coxa vara deformity, and the compression of vertebrae results in diminished stature and a kyphosis.

(4) Skeletal Tendency to Spontaneous Fracture: The tendency to spontaneous fracture may be due to accompanying osteoporosis or to the diminished resilience of bone structure following infarction. It is unusual to see fractures through overt infarcts.

Visceral Changes. (1) Abdominal Changes: Hepatic and splenic enlargement can sometimes be detected radiologically. In long-standing cases, spotty or irregular plaques of calcification may be detectable within the spleen. This is calcification within old splenic infarcts. Cholelithiasis sometimes occurs in young persons.

(2) Pathological Changes in the Lungs: Lung changes appear as segmental or lobar consolidation. These are presumably inflammatory processes occurring during the acute episodes of the condition, but the segmental lesions have been shown at autopsy to be often pulmonary infarcts.

(3) Cardiac Enlargement: In acute cases, especially in childhood, there is often considerable cardiac enlargement. This is considered to be the consequence of the adjustment to anemia. The cardiac silhouette may sometimes suggest a coexisting pericardial effusion, but there is rarely clinical evidence to support this.

The author makes an attempt throughout the discussion to link the radiologic changes with the hemoglobin picture and the pathologic conditions produced.

Twenty-four roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

RADIOTHERAPY

Epidermoid Carcinoma of the Lower Lip; Results of Radiation Therapy of the Local Lesion. William S. Gladstone and H. Dabney Kerr. *Am. J. Roentgenol.* 79: 101-113, January 1958. (W. S. G., 458 W. South St., Kalamazoo, Mich.)

From 1931 to 1951, 519 cases of epidermoid car-

cinoma of the lower lip were treated by irradiation at the State University of Iowa Hospitals. The average and mean ages in the series were 62.9 and 64 years respectively; 3.1 per cent of the patients were females. The right and left lateral aspects of the lip were more frequently involved than the midline, and involvement

at the angle of the mouth was relatively uncommon. Contact or superficial roentgen therapy was used in 81 per cent of the cases, deep roentgen therapy in 3.3 per cent, and radium in 5.1 per cent, with combinations of these technics in 10.6 per cent.

In 88.4 per cent of the patients there was no demonstrable metastasis at the time of the first visit. The remainder had submental, submaxillary, and anterior cervical lymph node involvement, with distant metastasis in a single instance. The absolute three- and five-year survivals were 74.2 per cent and 65.1 per cent respectively. With respect to control of the local lesion, the results showed a three-year cure rate of 84.7 per cent and a five-year success of 82.8 per cent. Lesions under 2.0 cm. in diameter had a three-year cure rate of 92.2 per cent, while those over 2.0 cm. showed a 76 per cent satisfactory response. If previous treatment by surgery, cautery, caustics, or irradiation had not been used, the three-year successful treatment rate was 90.9 per cent. In the cases in which one or more of these agents had been employed, the percentage of cures fell to 70.

In an effort to evaluate any improvement in results with modified irradiation technics introduced in later years, the series was divided into two ten-year periods. The three- and five-year net results for the 328 cases treated from 1931 through 1940 were 82 per cent and 79.5 per cent, respectively. In the 191 cases from 1941 through 1950 these figures rose to 90 per cent and 88 per cent, respectively.

Fourteen photographs; 2 charts; 10 tables.

WYNTON H. CARROLL, M.D.
Shreveport, La.

A Survey of Tongue Cancer Over a Fifteen Year Period in a General Hospital. Donald P. Shedd, Norman L. Schmidt, and Chu H. Chang. *Surg., Gynec. & Obst.* 106: 15-24, January 1958. (Yale-New Haven Medical Center, New Haven, Conn.)

Ninety-one patients with cancer of the tongue were seen at the Yale-New Haven Medical Center from 1940 to 1955. Various combinations of surgery and radiation therapy, including roentgen rays, radium, and radon, were used with disappointing results. The five-year survival rate for the whole group was 20.4 per cent.

An attempt has been made to standardize the care of such patients and the following technics are now employed. If radiation is chosen, roentgen therapy is used in the usual high-voltage, multiple-portal technic, to deliver a tumor dose of 2,000 to 2,500 r in two to three weeks. After a week of rest, low-intensity radium needles (about 0.66 mg. per centimeter of active length) are used according to the Paterson and Parker system, for a dose of about 4,000 to 4,500 gamma roentgens in three to four days. If the lesion is small and localized to the anterior part of the tongue, interstitial radium implantation is used as the sole form of therapy for a tissue dose of 7,000 gamma roentgens in five to six days.

The present policy of the University Service toward lingual cancer is as follows: *Stage I lesions* (less than 2.0 cm. in diameter), particularly if near the tongue border, can be cured either by radiation or adequate local excision. Anterior lesions 2.0 to 4.0 cm. in diameter may be handled by adequate excision, which may mean hemiglossectomy, or by irradiation. Lesions near the midline influence the decision toward irradiation.

For *Stage II lesions* (extension to adjacent tissues) the "composite operation" is recommended, in which the involved tongue is resected in continuity with the ipsilateral cervical lymph nodes, usually with sacrifice of the hemimandible. In *Stage III* (lymph nodes involved, with or without adjacent tissue involvement) radical neck dissection is advised, usually in combination with the composite operation. In *Stage IV* (distant metastases) irradiation is used for palliation.

For various reasons, three-fourths of the patients in the present series received radiation therapy. Some refused surgery, others were in poor general health, some had lesions which were too advanced, but numerous patients were selected because it is the authors' belief that this remains the primary approach to treatment of many tongue cancers.

Thirteen figures; 8 tables.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Treatment of Pituitary Adenomas; Surgery Versus Radiation. Gilbert Horrax. *Arch. Neurol. & Psychiat.* 79: 1-5, January 1958. (Lahey Clinic, Boston, Mass.)

The treatment of primary adenomas of both the chromophobe and chromophile variety has undergone considerable change during the course of the past fifty years. In the early days, surgical evacuation of the adenoma was the only known method by which vision could be restored in these patients. Gradually it was found that operation followed by irradiation was more effective than operation alone, and this led to a trial of radiation before surgical therapy was undertaken. Until the adoption of higher x-ray doses (preferably 4,000 r tumor dose), however, about 60 per cent of patients receiving previous irradiation had to be operated on because radiation alone was not effective.

The author considers the treatment results under four headings, depending on the method employed. (1) Fifty-four patients were treated by surgery alone. Twenty-eight of this number are known to have lived from five to twenty years and 23 had maintained their improvement for the period of survival. (2) In 61 cases preoperative irradiation was given, and 46 patients lived for five to twenty years, 44 maintaining their improvement. (3) Twenty-five patients were given a course of irradiation following operation. Twenty-four of these, followed for one to twenty years, had an average survival of 8.2 years, with improvement for an average of 7.2 years. Twenty-two lived for more than five years and 18 maintained their improvement for five to sixteen years. It is perhaps of some significance that this group showed the longest average survival and maintenance of improvement. (4) A fourth series were treated primarily by radiotherapy, for visual loss. These patients are considered in two groups: those treated prior to 1950, by tumor doses not exceeding 2,000 to 2,500 r, and those treated from 1950 on, receiving tumor doses of 4,000 r by the rotational method, with a 2,000,000-volt apparatus. There were 89 patients in the earlier group but, of these, 56, or 62.9 per cent, were operated upon subsequently because vision was not held at a useful level. In the more recent period (1950-56), there were 66 patients, and at the time of the report only 8 or 12.1 per cent of these had required operation because radiation was ineffective. It must be admitted that a one- to six-year follow-up period may not be long

enough to give the complete picture, but the difference in the two percentages is something that cannot be overlooked.

C. CHAFFIN, M.D.
Mercy Hospital, Pittsburgh

Malignant Lymphoma of the Thyroid. J. W. Welch, V. E. Chesky, and C. A. Hellwig. Surg., Gynec. & Obst. 106: 70-76, January 1958. (Hertzler Clinic, Halstead, Kans.)

Four sarcomas originating in the thyroid gland were found among 215 malignant tumors of the thyroid removed surgically at the Hertzler Clinic (Halstead, Kans.) between 1940 and 1955, an incidence of 1.8 per cent. Described, but not included as a sarcoma, is a fifth case which proved to be a nodular goiter with leukemic infiltration of the thyroid. In addition to their own cases, the authors list the cases of thyroid lymphoma from the literature of the last thirty years.

The following conclusions are reached: "The clinical history of rapid onset of thyroid enlargement, coupled with symptoms of dysphagia, dyspnea, weakness, weight loss, and hoarseness, are classical for the disease and are consistent enough to constitute a syndrome. It is believed that primary thyroid lymphoma arises from pre-existing lymphoid tissue present in the gland as a result of inflammation. Attention is drawn to the difficulty of distinguishing histologically thyroid sarcoma from anaplastic carcinoma as well as the primary lesion from malignant invasion."

Including the leukemia case, 4 of the 5 patients received postoperative roentgen therapy. From 2,000 to 2,340 r was given to one or two portals about the neck. The exact factors are not stated. The lesions were sensitive and the immediate response was good. Of the 4 who received roentgen therapy, 1 was dead after five months, and 1 after six years; 1 was alive after six months and 1 after 9 months.

Four photomicrographs; 4 photographs; 2 tables.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Therapy of Carcinoma in Situ: Implications from a Study of Its Life History. Richard W. Te Linde, Gerald A. Galvin, and Howard W. Jones, Jr. Am. J. Obst. & Gynec. 74: 792-799, October 1957. (Johns Hopkins University School of Medicine, Baltimore, Md.)

In 24 of 812 cases of invasive carcinoma of the cervix, biopsy material obtained one to twenty years prior to the final diagnosis was available. A review of this material showed carcinoma *in situ* in 17 cases and basal-cell hyperactivity in 3; in only 4 was no abnormality noted. Over the same period of time 211 patients received definitive therapy for carcinoma *in situ* in the same clinic. In 15 of this group cervical biopsies taken one to ten years before treatment were available for a parallel retrospective inquiry. Restudy of these biopsies revealed carcinoma *in situ* in 4, basal-cell hyperactivity in 10, and normal epithelium in 1.

Treatment of the 211 cases consisted in removal of the uterus, 2 cm. of parametrial tissue, and the same amount of vaginal cuff, with preservation of one or both ovaries in the younger patients. Two patients were lost to follow-up, but the remainder were living and apparently well at the time of this report. In 5 patients there was an interval of twenty months to three years between diagnosis and treatment and in one pregnant patient three months elapsed before

treatment was undertaken. In all 6 the disease had progressed to Stages I, II, or III.

The authors' observations confirm the belief that carcinoma *in situ* frequently develops into invasive carcinoma if untreated or treated by a surgical procedure of less magnitude than a hysterectomy.

Two tables.
ROBERT L. EGAN, M.D.
University of Texas, Houston

Evaluation of Surgical Procedures Employed Following the Failure of Irradiation Therapy in Cancer of the Cervix. Herbert E. Schmitz, Charles J. Smith, David V. Foley, and Colin B. Schack. Am. J. Obst. & Gynec. 74: 1165-1173, December 1957. (Stritch School of Medicine, Loyola University, Chicago, Ill.)

While irradiation is widely accepted as the treatment of choice for cervical cancer, there remain a certain number of cases in which surgery is required because of failure of radiotherapy, either as a result of a primary state of radioresistance or an inadequate initial course of therapy.

The authors review a series of 120 operations for pelvic cancer, including 69 radical hysterectomies with lymphadenectomy and 51 complete or partial exenterations. Eighty of the patients had previously been treated by irradiation. The high mortality, morbidity, and disability were similar to those reported by others.

Surgical injuries were three times as common in the previously irradiated patient. Mortality rates were in direct proportion to the magnitude of the surgery undertaken. With a lesion clearly localized to the cervix the prognosis for five years was excellent. The two- to five-year salvage rate in all types of exenteration was 23.5 per cent. The two- to five-year salvage rate in cases treated by extirpation of the genital organs alone was 74.3 per cent. The hospital mortality in 51 exenterations was 33.3 per cent. The status and recovery of the upper urinary tract profoundly influenced the survival rates.

The patient suffering from recurrent or persistent carcinoma challenges the imagination, judgment, and technical skill of the cancer therapist. The brightest hope lies in the development of means of determining the presence of radioresistance prior to any therapy. There is growing conviction that when lymph nodes are involved there is little superiority of either the surgical or irradiation method of approach.

[This is a clear report of a sizable series, devoid of far-reaching claims, reflecting much thought and worthy of study by the cancer therapist.—R. L. E.]

Thirteen tables.
ROBERT L. EGAN, M.D.
University of Texas, Houston

Rectal and Bladder Injuries Following Radium Therapy for Carcinoma of the Cervix at the Radiumhemmet. Mary Jane Gray and Hans L. Kottmeier. Am. J. Obst. & Gynec. 74: 1294-1303, December 1957. (H. L. K., Radiumhemmet, Stockholm, Sweden)

Out of 500 consecutive cases of invasive carcinoma of the cervix, complete physical measurements of radiation dosage to the bladder and the rectum were available in 369. The patients were treated according to the current modification of the Stockholm technic, which stresses individualization of cases. The period was from July 1953 to September 1954, during which time a 0.3 c.e. Sievert ionization chamber in a probe was used in the bladder and rectum.

In this report an attempt is made to correlate injuries with an objective measurement of the dose in roentgens delivered to the mucosa of the bladder and rectum and with the size and intensity of the intrauterine radium application. The increased intrauterine dose in advanced lesions has been responsible for increased survival rates, but has necessitated a re-evaluation of radiation injuries.

Within the dose range studied there was little correlation between bladder injuries and the measured dose of radiation, but in a few patients with a total dose to the mucosa of more than 7,000 r there was a rise in severe bladder injuries. In 168 Stage II lesions in which there was an increased intrauterine dose there appeared to be no effect on the bladder.

With a total dose to the rectum of less than 6,000 r serious injuries occurred in 4.2 per cent, but with doses above 6,000 r this figure rose abruptly to 15.3 per cent. A somewhat similar rise in rectal injuries occurred with increase in the dose above 5,000 gamma r. A significant increase in rectal injuries with increased intensity of radium treatment was demonstrated; a dose of 2,400 gamma r to the rectum in twenty-four hours is the maximum which should be used. A narrow vagina, as reflected by the type of applicator which could be accommodated, was of significance in increasing the probability of rectal injury.

Eight tables.

ROBERT L. EGAN, M.D.
University of Texas, Houston

Malignant Neoplasia in the Endometrium: A Ten-Year Experience in Private Practice. John A. Wall and René Mastrovito. *Am. J. Obst. & Gynec.* **74**: 866-874, October 1957. (Baylor University College of Medicine, Houston, Texas)

A series of 70 cases of carcinoma of the corpus uteri is reported. Forty-nine of these were treated by a combination of irradiation and surgery. Where possible, this consisted in two radium implantations, three weeks apart, by the Heyman packing method, plus vaginal radium, followed in four weeks by total hysterectomy and bilateral salpingo-oophorectomy.

Six patients were excluded from combined therapy as poor surgical risks or because of advanced disease, and 15 because of other reasons. Six of the group receiving combined therapy had irradiation elsewhere, 6 had only one radium application, in 5 the uterus was too small for adequate radium implantation, 3 had lesions of both the corpus and cervix, and 1 had a double uterus. Twenty-eight patients received what was considered optimal radium and only 4 of these showed residual tumor at hysterectomy.

Insufficient time has elapsed for five-year results, but the prognostic value of the presence or absence of residual tumor appears significant.

Numerous discussants of the paper offer their views, supported by their own statistics. These are usually highly in favor of combined therapy for endometrial carcinoma, but at least one commentator considers that in endometrial carcinoma "preoperative radium probably is an unnecessary gesture."

In addition to his consideration of treatment, the author gives special attention to the high preponderance of endocrine stigmata found in endometrial cancer and to the value of endometrial biopsy as a means of immediate diagnosis.

Six tables.

ROBERT L. EGAN, M.D.
University of Texas, Houston

Treatment and Prognosis in Cancer of the Ovary, with a Review of a New Series of 143 Cases Treated in the Years 1944-1951. Equinn W. Munnell, Harold W. Jacox, and Howard C. Taylor, Jr. *Am. J. Obst. & Gynec.* **74**: 1187-1200, December 1957. (College of Physicians and Surgeons, Columbia University, New York)

The results of treatment of 148 cases of cancer of the ovary, from 1944 to 1951, inclusive, have been reviewed and compared with the results in cases treated from 1924 to 1943 (Munnell and Taylor: *Am. J. Obst. & Gynec.* **58**: 943, 1949. *Abst. in Radiology* **55**: 633, 1950). No significant improvement was noted over the earlier period.

The importance of histogenic type, histological grade, and stage of clinical extension in prognosis has again been stressed. No methods for earlier diagnosis have been advanced, and the surgical approach has not changed significantly. There was objective improvement in 14 of 27 cases treated with thio-TEPA. The use of the 24-million-volt x-rays produced by the betatron prevented high doses to the skin but did not make a radioresistant tumor more sensitive. Au^{198} has been shown to prevent or delay accumulation of ascitic fluid without a significant effect on cure rates.

In the more recent group of 148 cases of carcinoma of the ovary the five-year cure rate was 27.7 per cent; in the earlier group of 200 cases it was 27.5 per cent.

One photomicrograph; 8 graphs; 6 tables.

ROBERT L. EGAN, M.D.
University of Texas, Houston

Clinical Impressions in 100 Consecutive Cases of Carcinoma of the Urinary Bladder Treated by Supervoltage. Carlo A. Cuccia, Sid Jones, and Cecil M. Crigler. *J. Urol.* **79**: 99-109, January 1958. (M. D. Anderson Hospital, Houston, Texas)

It has been the opinion of most workers that infiltrating carcinoma involving the bladder wall cannot be cured by supervoltage irradiation and that this should be reserved for superficial anaplastic carcinomas. It was the authors' feeling, however, that the possibilities of supervoltage therapy needed more thorough investigation in this large group of tumors, where previous results have been poor both with surgery and irradiation.

Since April 1954, the emphasis at M. D. Anderson Hospital has been directed toward radical irradiation and, except for those cases of superficial low-grade carcinoma treated transurethrally, irradiation has been given precedence over other forms of surgical procedure. The decision to treat the whole empty bladder rather than a part of it and to prefer external irradiation in cases that could have been handled by interstitial or intracavitary irradiation was influenced strongly by the demonstration of circumferential lymphatic spread of cancer cells along the muscle walls. The large majority of cases were treated on a clinical basis entirely, making classification somewhat uncertain, and the criteria of classification used are explained.

Some 150 patients have been treated since April 1954, and this report is concerned with the first 100. All cases were treated with either the cobalt-60 irradiator or the betatron. Initially patients were alternated, with a view to evaluating possible differences in tolerance, reactions, and immediate results. No significant differences were found. More recently

use of the betatron has been preferred because of better volume distribution. The usual treatment has consisted in delivery of a minimum tumor dose of 6,000 r in five weeks, with a three-field arrangement. The fields, one anterior in the suprapubic region and two posterior at the level of the sacroiliac joints, ranged in size from 6×8 to 8×10 cm.

In some instances when the patient had had previous suprapubic surgery the minimal tumor dose was reduced to 5,500 r. In palliative cases a somewhat lower dose—3,500 to 4,500 r—was delivered in three to four weeks. This was found to be more desirable in patients with extravescicular extension of the disease to the pelvic wall and in those with less extensive disease but in poor general condition.

The amount of dysuria and urgency during treatment was usually related to symptomatology prior to treatment. If bladder neck obstruction or urethral stricture is present, there is accentuation of symptoms early in the course of treatment. Postponement of irradiation is considered justifiable until such conditions are corrected. Eighteen patients had major complications, including rectal or bladder bleeding in 11 instances and contracted bladder in 10. There appears to be a definite relationship between recent suprapubic surgery, especially partial cystectomy, and contracted bladder. There were 2 deaths attributable to the complications, both related to severe uncontrolled bleeding from bladder or rectum.

The authors conclude that supervoltage therapy has a definite place in management of bladder neoplasms. High-grade lesions, including undifferentiated and squamous carcinoma and infiltrating lesions with extension short of the pelvic wall, should be treated radically. Results in this group have been very encouraging. Analysis of the superficial low-grade group has shown that the potentiality of the bladder mucosa to form new lesions was not eradicated by irradiation. Therefore, low-grade, low-stage lesions are probably best handled by transurethral surgery. Recurrences that reveal increase in stage and/or in grade, or lesions that cannot be adequately removed transurethrally, can be eradicated by irradiation.

Two roentgenograms; 3 drawings; 11 tables.

CHARLES M. GREENWALD, M.D.
Iowa City, Iowa

A Study of Hodgkin's Disease Treated by Irradiation. M. Vera Peters and K. C. H. Middlemiss. *Am. J. Roentgenol.* **79**: 114-121, January 1958. (M. V. P., Department of Radiotherapy, Toronto General Hospital, Toronto, Canada)

A series of 291 cases of Hodgkin's disease treated in the Department of Radiotherapy, Toronto General Hospital, from 1928 to 1954 has been studied with relation to five-, ten-, fifteen-, and twenty-year gross survival rates, initial sites of disease and factors determining the prognosis. The following conclusions are drawn:

1. The cervical lymph nodes are by far the most frequently noted initial sites of the disease.
2. The stage of the disease still ranks first as an important factor in evaluating the prognosis.
3. A ten-year survival without recurrence after the initial control is necessary before one can be reasonably confident of a cure, as shown by the year-to-year drop in survival rates.
4. A significant ten-year survival by stage has now

been established: Stage I, 58 per cent; Stage II, 35 per cent; Stage III, 2 per cent, based on comparable numbers of cases in each group.

5. A history of symptoms of generalized disease is the second most significant factor in prognosis, the ten-year survival with such a history being 6 per cent as opposed to 60 per cent in the absence of such symptoms.

6. The incidence of Hodgkin's disease rises with advancing age to a peak at thirty years of age, after which it recedes, but the twenty to thirty year decade has the best survival rate.

7. The female sex, while in the minority in incidence, has at least a 10 per cent better prognosis.

8. The duration of the disease reflects its chronicity, according to the stage. In general, the early cases of long duration had longer survivals without recurrence.

9. Deliberation and sometimes a period of observation are of importance before a decision is reached as to the plan of treatment. The survival rates and the incidence of recurrences reveal that there is at least a 35 per cent error in clinical staging. This fact must be borne in mind when initial treatment is planned.

10. Prophylactic irradiation of at least all proximal lymph node regions is estimated to have increased the survival rates at least 20 per cent.

11. The chemotherapeutic agents have been useful in prolonging life in selected cases. A possible increase in the survival rates up to five years is demonstrated.

12. Pregnancy, particularly following initial control of the disease, does not appear to alter the prognosis.

Fifteen tables. WYNTON H. CARROLL, M.D.
Shreveport, La.

Effects of Radiation on Metastatic Lymph Nodes from Various Primary Carcinomas. Ruth J. Guttman. *Am. J. Roentgenol.* **79**: 79-82, January 1958. (Francis Delafeld Hospital, New York, N. Y.)

The author sought to determine whether it is possible by irradiation to sterilize lymph node metastases. With this in view metastatic nodes in 12 cases of squamous carcinoma and 11 cases of mammary adenocarcinoma were examined microscopically before and after radiation treatment. All patients received an identical tumor dose of 5,000 r delivered in five weeks, with either the 2-million-volt or the cobalt-60 unit. Lymph nodes and primary lesions were treated in the same fashion. From these cases the following observations were made:

1. There seemed to be no difference in the response to irradiation between metastatic squamous carcinoma and adenocarcinoma.
2. There was no difference in the response of lymph nodes in different areas.
3. Smaller lymph nodes responded better than large ones.
4. Metastatic lymph nodes could be sterilized by irradiation while there was still persistent disease present in the primary area.

Five tables. WYNTON H. CARROLL, M.D.
Shreveport, La.

A Graphic Method of Reconstructing Radium Needle Implants for Calculation Purposes. Martin De Forest Smith, Jr. *Am. J. Roentgenol.* **79**: 42-48, January 1958. (8425 W. Third Place, Lakewood, Colo.)

Since true end-on views of radium needle implants are difficult or sometimes impossible to achieve for

dosimetric calculations, the author has sought to obtain such views by geometrical projection. He presents a method for constructing a graph to give an end-on projection of an interstitial implant from which measurements can be directly taken, giving the curvature, angulation, and size of an implant or the separation between the planes of a multiple-plane implant.

The graphic projection of radium implants is based upon the fact that the location of an object in space is determined by its relation to any three-dimensional reference system and is represented by its projection on the three right-angle planes defined by the axes of such a reference system. If the object can be defined in two planes, the projection on the third plane can be constructed.

Two standard right-angle roentgenograms are obtained. An example is given in which the desired axis of projection for obtaining the end-on view was along the axis of the needles. An x-z plane representing the position of the needles in an anteroposterior film and a y-z plane representing the needles in a lateral film are constructed. The common side of the film represents the z-axis. Any two lines drawn on the films which are perpendicular to the common side may be used to construct the desired projection. Points on the films representing the ends or centers of the needles are projected perpendicularly onto the base lines and distances from the common edge of the projected points are plotted on graph paper to obtain the x-z projection. Examples are also given for angled implants, and a graph is constructed which can measure not only the angulation but also the total width of the implant.

These procedures are applicable only when the desired axis of projection is parallel to the common edge of the films (the z-axis). If this is not the case, the radium system must actually or theoretically be rotated in space to meet this condition before such a graphic projection can be made. Theoretical rotation of a radium implant can be accomplished by the rotation of the original roentgenograms so that the coordinates of one three-dimensional reference system are transposed to those of another in which the desired axis of projection for an end-on graph is parallel to the z-axis. In instances where it is impossible to obtain a pair of right-angle roentgenograms, a double rotation must be performed.

An outline of the methods of constructing graphs to give end-on projections of interstitial implants cannot be considered adequate without the illustrations that accompany the original text, and to this the reader is referred for details.

Seven figures.

JOHN W. WILSON, M.D.
Johnstown, Penna.

The Dose-Time Relationship in Radiation Therapy: High Dose, Prolonged Time, Large Volume Radiation Therapy; The Limits of Tolerance. J. Robert Andrews, Philip Rubin, and Robert W. Swain. *Am. J. Roentgenol.* 79: 64-73, January 1958. (J. R. A., National Cancer Institute, National Institutes of Health, Bethesda, Md.)

It has been shown experimentally and by mathematic equation that a biologic response to radiation therapy is a function of dose and time as well as many other unknown variables in biologic materials themselves that cannot be defined or quantitatively evaluated. The biologic response is further determined by the

sensitivity of the individual cells and their recovery propensities. The authors present a preliminary report on 13 patients with inoperable or extensive cancer of the upper respiratory tract, oral cavity, or pharynx, treated with 2-MEV roentgen rays for tumor doses of 8,000 to 10,000 r in periods of eighty to one hundred days. This study was undertaken to determine whether protraction of radiation treatment at comparable increments in dose results in greater cancerocidal effect and diminished normal tissue effect. Both rotational and fixed field techniques were employed. The results in this small group of cases were ultimately poor, with only 4 patients living at the time of this analysis. One had survived twenty-two months with disease, and a second ten months with disease; a third was well six months after treatment with no evidence of disease, and the fourth was living at five months and had shown a fair immediate response but was not considered cured. It is not known whether these poor results are reflections of the extensive stage of the tumors or of the treatment employed.

The reactions to the radiation therapy were in general intense in those patients where the oral or oropharyngeal cavities were irradiated and mild or moderate in patients irradiated for sinus or nasopharyngeal tumors. There was a high correlation between the severity of the reactions and the size of the fields. The average size of the fields in the cases with severe reactions was 90 sq. cm. and in those having mild reactions, 63 sq. cm.

Tumor response was highly variable. In 6 cases, the cancer was not controlled even temporarily at primary and secondary sites with exposure doses of 8,000 to 10,000 r delivered in one hundred days. Conversely, doses of the same magnitude resulted in initial resolution of the presenting cancer in 4 cases. Exceptionally severe reactions occurred in 3 patients. In 1 there was edema of the entire oropharynx, and in another actual gangrene of the anterior third of the tongue. The third showed a persistent hard edema of the neck at the site of therapy after having been previously treated elsewhere with 2,000 to 3,000 r of medium-voltage roentgen rays. Skin reactions were of no consequence and never exceeded moderately deep tanning with perhaps dry desquamation. No complications were observed in the mandible or maxilla except in one case in which a localized necrosis of the alveolus appeared at the site of extraction of a posterior molar.

The authors feel that the normal tissue tolerance in the oral cavity and oropharynx was reached or exceeded with tumor doses of 10,000 r through an area of 90 sq. cm. in one hundred days. On the other hand, doses of 8,000 r given in eighty-five to one hundred days through smaller fields (60 sq. cm.) were well tolerated. Differential neoplastic and normal tissue effects were not observed which could be accounted for by the prolonged extension of the treatment time. The authors conclude that the average cancerocidal dose and tissue tolerance dose for large volumes treated for an extended period are either similar or that the former exceeds the latter. Although the tissue tolerances were thought to be reached by the higher dose levels, the authors feel that doses of this order are not necessarily cancerocidal. Further improvement in the results of radiation therapy may have to be sought in the use of pharmacologic modifiers of response in neoplastic and normal tissues.

It should be remembered that the conclusions are applicable only to the set of conditions under which the study was carried out. The number of patients was small. The radiation reactions were evaluated without controls and were compared to what the authors might have expected had shorter times and lower doses of radiation been employed. Also, the exaggerated protraction and exaggerated increment in total dose may exceed an optimum time-dose relationship; but it may be concluded as a preliminary observation that these factors, as used in this study, did not appear to enhance the therapeutic ratio of lethal tumor response and normal tissue recovery.

Four tables.

JOHN W. WILSON, M.D.
Johnstown, Penna.

Some Aspects of Supervoltage Radiation Therapy. W. J. Meredith. *Am. J. Roentgenol.* 79: 57-63, January 1958. (Christie Hospital and Holt Radium Institute, Manchester 20, England)

In view of the widespread use of supervoltage therapy, the author has examined the properties of this type of radiation to determine its advantages and to establish whether there is an optimum energy level which is most effective.

The most obvious advantage of supervoltage radiation is the increment in depth dose, which enables the therapist to give a particular treatment with a smaller number of fields or with a smaller dose to each field than at 250 kv, producing less systemic effect because of lower skin and integral doses. A second advantage is the decrease in scatter, so that the radiation is more confined and the normal tissues adjacent to the incident beam are spared. With less damage of normal tissues, recovery is more prompt.

Depth dose measurements are made in water or similar material of unit density and therefore may not be applied precisely when tissues of different densities must be traversed. Bone notably affects the irradiating beam. At higher photon energies, the absorption coefficient of bone approaches more nearly that of tissues of unit density and, therefore, supervoltage radiation depth dose values and isodose curves are less affected by the interposition of bone. Consequently, these measurements, as prepared from a water phantom, are more accurately adaptable to super-

voltage radiation than to radiations of lower kilovoltage. It is also shown that the ionization concentration in bone is less at supervoltage therapy levels, so that the biologic effect upon bone is reduced, which constitutes another major advantage of supervoltage treatment.

At extremely high energy radiations, pair production is increased in bone and the relative energy absorption in bone increases; the range of the secondary electrons is enhanced and the dose received by soft tissues in or near bone is also increased. This is one disadvantage of the therapeutic use of radiation energies above 4 or 5 MEV. A second disadvantage is the increment in the exit surface dose. Although this is not likely to be a factor grossly limiting any treatment, it is to be avoided if possible.

At higher energies, the radiation is sharply concentrated in the direction of the producing electron stream so that it is necessary to introduce "beam flattening" filters to achieve a uniform beam. These compensating filters reduce the central intensity and thereby reduce the economic output. Also, the higher the energies of the radiation source, the larger and more expensive is the apparatus and the greater the required protection cost. These are nonbiologic disadvantages of supervoltage therapy.

It is reasoned that disadvantages of increasing pair production, increasing exit doses, and increasing operational and cost problems vary proportionately as the photon level energies are increased. Weighing these disadvantages against the advantageous factors of increased depth dose, diminished bone absorption and biological effect in bone, reduced surface entrance dose, reduced integral dose and systemic effects leads to the conclusion that an optimum generating voltage for supervoltage radiation therapy is somewhere around 5 million volts and within a range of 3 to 8 million volts.

Radiation in these optimum levels can be delivered most efficiently by radiocobalt telecurie units or linear accelerators. For technical and biological effectiveness, the latter have distinct advantages, and ultimately the choice between these two machines is based on financial consideration.

Five graphs.

JOHN W. WILSON, M.D.
Johnstown, Penna.

RADIOISOTOPES

Intracavitary or Interstitial Use of Isotopes in Carcinoma of the Urinary Bladder. Carlo A. Cuccia. *J. Urol.* 79: 94-98, January 1958. (M. D. Anderson Hospital, Houston, Texas)

Carcinomas of the bladder are divided into four groups for consideration of the various forms of isotope irradiation.

1. For multiple small noninfiltrating lesions intracavitary isotopes in liquid form, mainly beta emitters, are used. These provide a high dosage to superficial structures with a sharp fall off so as to spare the more peripheral parts of the viscus. Na^{24} , Br^{82} , and Au^{198} have been employed, usually contained in a bag. However, Au^{198} has recently been introduced directly into the bladder.

2. In the presence of multiple lesions of the urinary bladder with infiltration of the muscle, intracavitary gamma-ray emitters are used to provide increased

depth dose. The most widely used procedure is a central radium source placed in the center of an inflated bag. Co^{60} or cesium may be used, but the essential problem remains that of careful centering of the source.

3. For single infiltrating lesions of the bladder not larger than 5 cm. in diameter, interstitial implantation with any gamma emitter may be employed (radium, radon, Co^{60} , cesium, Ta^{182} , Au^{198}). In thicker exophytic lesions, part of the tumor should be shaved off before implantation. An implant of flexible tantalum wire is perhaps to be preferred to the classical implant with radium needles—which because of their rigidity are less suitable to follow the curvature of the bladder. Also, in using tantalum wires, the bladder can be closed and the wires easily withdrawn through the urethra.

4. Deeply infiltrating lesions with involvement of

the paravascular areas are not suitable for intracavitary or interstitial treatment, which would leave viable cells out of the area of useful irradiation.

The author concludes by stating that in these types of local treatment, using either beta or gamma ray emitters, the most difficult thing is to select the cases which present the right indications for each one of the procedures. Selecting one rather than another isotope will depend mainly upon technical considerations rather than upon differences in the basic physical principles or biological effectiveness.

Four figures. CHARLES M. GREENWALD, M.D.
Iowa City, Iowa

The Use of Interstitial Radium Dose Rate Tables for Other Radioactive Isotopes. John Hale. *Am. J. Roentgenol.* 79: 49-53, January 1958. (3400 Spruce St., Philadelphia 4, Penna.)

Standard radium exposure dose rate tables are used for dose determinations from radioactive isotopes by multiplying the rates in the table by the ratio of the specific gamma-ray emission of the isotope to that of radium. This procedure, however, neglects differences in absorption and scatter. A formula is given for determining the exposure dose rate in air from a point source isotope. Another formula is given for the isotope dose rate in an infinitely large water phantom. In this instance, the dose rate at any given point will be altered by two factors: (A) the absorption of gamma rays in the water and (B) the scattering of some of the gamma rays so that they enter the point of interest, produce ionization, and increase the measured dose rate. The product of B, the "build-up" factor, and A, the absorption factor, is the correction factor which should be applied to a dose rate in air when it is desired to obtain the dose rate at the same relative point in water. To apply radium dose rate tables to an isotope, not only must the dose be multiplied by the ratio of the specific gamma-ray emission of the isotope to radium but also by the product of the build-up and absorption factors.

In calculating the water-air dose rate ratio, the authors find that the absorption factor and build-up factor nearly cancel each other over a wide range of distances and of gamma-ray energies. Within 5 cm. of the source, the correction factor is less than 10 per cent for gamma-ray energies between 0.25 and 2 MEV. Since most clinically used isotopes have average gamma-ray energies within this range, neglecting the correction factor of build-up and absorption is justified if a plus or minus 10 per cent limit is acceptable. For gamma-rays with an energy of 0.4 MEV, the absorption and build-up factors balance. For lower energies, the build-up factor predominates. For higher energies, the absorption factor is more significant. Consequently, the dose rate in water is higher than in air for lower energies and the dose rate in water is lower for higher energies. This is applicable when the distances from the point source are less than 10 cm.; for a greater distance, the absorption factor always predominates.

A chart is shown illustrating the data of computed water-air dose rate ratios for Hg^{203} , Ir^{192} , Au^{198} , radium, and Co^{60} . In comparing the computed results with experimental results, it was found that the former are approximately 3 per cent higher on the average.

Four charts; 2 tables. JOHN W. WILSON, M.D.
Johnstown, Penna.

Thyroid Function in Subacute Thyroiditis. Robert Volpé, MacAllister W. Johnston, and Norma Huber. *J. Clin. Endocrinol.* 18: 65-78, January 1958. (Toronto General Hospital, Toronto, Canada)

This paper describes the changing pattern of thyroid function in patients with subacute thyroiditis. Fifty-six cases were studied, 21 of which were followed through the unmodified natural course of the illness, while 35 were treated by radiation, cortisone, or surgery.

The cases were classified as severe, moderately severe, and mild. Charts recording I^{131} uptake and serum PBI levels during the various phases of the disease are included. In 11 very severe cases the initial extensive inflammatory necrosis presumably led to flooding of the body with thyroid hormone, thus producing symptoms of hyperthyroidism with a high level of serum protein-bound iodine (PBI), an increased basal metabolic rate, and profound depression of thyroidal I^{131} uptake to virtually zero. Following the acute phase the patient passed through a euthyroid interval into a phase characterized by symptoms of hypothyroidism with a low level of serum PBI. During the later part of this phase the ability of the gland to concentrate iodine began to increase. During the recovery phase, the thyroidal I^{131} uptake rose to levels above normal in a rebound phenomenon, whereas the serum PBI gradually rose to levels that did not exceed the normal range.

In 15 moderately severe cases, the acute phase was similar in character but usually less severe. The thyroid glands of patients in this group were not sufficiently damaged to cause a hypothyroid phase. After the serum PBI level fell to a normal range, the ability of the gland to take up radioiodine also returned to normal, without the rebound phenomenon. In the 30 milder cases, there was neither a hyperthyroid nor a hypothyroid phase, but the thyroidal uptake of I^{131} was usually depressed for several weeks. In all cases there appeared to be complete recovery with no permanent sequelae.

Only two forms of treatment appeared to have a specific effect on the disease, namely, cortisone and irradiation. Deep x-ray therapy, from 200 r to 400 r total dose, was given to 24 patients, and 17 of these had relief of local pain and tenderness in a few days, as well as subsidence of the acute systemic manifestations. Radiation therapy seemed to arrest and shorten the acute phase of the illness, but the sequence of changes was the same as in the untreated cases.

Three patients received cortisone therapy, and it is felt that this may relieve the signs and symptoms more quickly than radiation.

Four charts; 1 table. W. J. VARLEY, M.D.
Mercy Hospital, Pittsburgh

The Differential Diagnosis of Intestinal Malabsorption with I^{131} -Fat and Fatty Acid. B. J. Duffy, Jr., and D. A. Turner. *Ann. Int. Med.* 48: 1-7, January 1958. (B. J. D., Georgetown University Hospital, Washington 7, D. C.)

One of the authors (D. A. T.) has developed a method for the preparation and use of I^{131} -labeled fat, as triolein or oleic acid, in the study of the absorption, utilization, and deposition of fat in both dog and man. The present report describes this method as a routine clinical procedure in the differential diagnosis of steatorrhea.

Fifty microcuries of the I^{131} -fat activity is administered to the fasting patient in olive oil as a carrier. A fat-free breakfast is given after the labeled meal to stimulate normal gastric and intestinal emptying and peristalsis. Samples of blood are then taken at intervals up to eight hours. The serum is precipitated and the I^{131} -lipid activity is measured, the results being expressed as lipid activity per cent of the administered dose per calculated blood volume.

The initial studies concentrated on the use of I^{131} -labeled fat as a measure of pancreatic insufficiency. I^{131} -triolein is a neutral fat which requires pancreatic lipase for its hydrolysis prior to absorption. In the absence or deficiency of pancreatic lipase, the neutral fat is not absorbed to any significant degree. There is an increased concentration excreted in the stool. Labeled oleic acid, on the other hand, does not require further lipolysis prior to absorption. This is the basis for the use of tagged neutral fat and fatty acid in the diagnosis of pancreatic insufficiency.

In chronic pancreatitis or cancer of the pancreas, a flat triolein tolerance curve is obtained and a significant, albeit impaired, absorption of the I^{131} -fatty acid is observed. The deficiency of I^{131} -oleic acid absorption may be partially explained by the administration of the tagged meal in olive oil. The use of I^{131} -fat and fatty acid does not differentiate chronic pancreatitis from pancreatic cancer as the cause of the pancreatic insufficiency. The main value of the test is to elicit information on the specific absence of pancreatic lipase in patients with unexplained gastrointestinal malfunction and "pancreatic" steatorrhea. Definite diagnosis would usually require surgical exploration and pathologic examination.

In regional ileitis (Crohn's disease), particularly in the advanced or surgically resected case, there is a significant steatorrhea. In no case of Crohn's disease, was there a difference in the neutral fat and fatty acid tolerance. In patients in whom the normal gastric-duodenal continuity has been altered, no consistent abnormality of fat absorption was found.

The major clinical utility of the I^{131} -lipid test is the differential diagnosis of steatorrhea. It is basically an attempt to provide a practical means of separating pancreatic insufficiency from other causes of fat malabsorption.

Seven diagrams.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Malabsorption Syndrome: Intestinal Absorption of Vitamin B_{12} . Sanford Oxenhorn, Solomon Estren, Louis R. Wasserman, and David Adlersberg. *Ann. Int. Med.* 48: 30-38, January 1958. (D. A., Mount Sinai Hospital, New York 29, N. Y.)

The common denominator of the conditions variously known as nontropical sprue, tropical sprue, celiac disease, and idiopathic steatorrhea is impaired intestinal absorption of various dietary substances. These several clinical entities may be grouped together under the term "malabsorption syndrome." Somewhat similar clinical pictures may be seen following intestinal resection, in blind loop syndrome, and in certain disorders which involve the intestinal tract, such as lymphosarcoma and intestinal lipodystrophy. These secondary types of "sprue" show, in contrast to the primary malabsorption syndrome, gross pathologic alterations of the intestinal tract. In both the primary and the secondary malabsorption syndromes,

characteristic changes in the hematologic picture may be encountered. In its severest form this consists of megaloblastic erythropoiesis in the marrow, with pancytopenia, including macrocytic anemia, in the peripheral blood.

The anemia of primary malabsorption syndrome is generally attributed to impaired absorption of dietary elements necessary for normal hematopoiesis. This report is concerned with the abnormality of absorption of one of these factors, vitamin B_{12} .

Twenty-five patients with idiopathic sprue were studied. The diagnosis was made on the basis of the typical clinical picture, supplemented by x-ray studies of the gastrointestinal tract, studies of absorption and excretion of fat, and tests for intestinal absorption of glucose and vitamin A. In addition, 3 cases of sprue secondary to resection of the small bowel (for jejuno-ileitis in 2 cases, for superior mesenteric artery occlusion in 1 case) were studied. Three cases were also studied in which a sprue-like syndrome (diarrhea, steatorrhea, macrocytic anemia) was present in patients with blind intestinal loops. The intestinal absorption of vitamin B_{12} was measured by the urinary excretion of radioactivity following the ingestion of a physiologic dose of Co^{58} - or Co^{60} -labeled vitamin B_{12} .

In the group of 25 patients with idiopathic malabsorption syndrome the average excretion of radioactivity was 3.6 per cent (normal 17.9 per cent). Of this group, 20 showed marked impairment of intestinal absorption of vitamin B_{12} , 4 had low normal results, and 1 was entirely normal. The 3 patients with sprue secondary to intestinal resection showed no absorption of the orally administered vitamin B_{12} and absorption was markedly impaired in the 3 patients with blind-loop syndrome. A repetition of the tests after the oral administration of a potent intrinsic factor showed no change in the findings.

The authors' observations indicate that a defect in intestinal absorption of vitamin B_{12} is among the most consistent measurable abnormalities in the malabsorption syndrome. Radioactive vitamin B_{12} may be added to the tools employed in the diagnosis of this syndrome.

One chart; 2 tables. STEPHEN N. TAGER, M.D.
Evansville, Ind.

Diverticulosis of the Small Intestine and Macrocytic Anemia with Report of Two Cases and Studies on Absorption of Radioactive Vitamin B_{12} . Harold H. Scudamore, Albert B. Hagedorn, Eric E. Wollaeger, and Charles A. Owen, Jr. *Gastroenterology* 34: 66-82, January 1958. (Mayo Clinic and Mayo Foundation, Rochester, Minn.)

To the 19 cases of macrocytic anemia associated with multiple diverticula of the small intestine already reported in the literature, the authors add 2 of their own. The absorption of radioactive vitamin B_{12} was determined in these 2 cases by the urinary excretion method (Schilling). The urinary excretion of vitamin B_{12} improved after administration of an antibiotic, oxytetracycline (Terramycin). In neither instance had it been improved by the intrinsic factor. In 1 of 3 other patients with jejunal diverticulosis without anemia, impaired absorption of vitamin B_{12} was not altered by adding intrinsic factor but became normal after oxytetracycline. These results add evidence in support of the concept that in small bowel diverticulosis vitamin B_{12} deficiency develops as a result of bacterial interference with intestinal absorp-

tion of vitamin B₁₂ in a manner not as yet understood.

Two roentgenograms; 1 photograph; 1 chart; 3 tables.

HOWARD J. BARNHARD, M.D.

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Radiation Sterilization of Homogenous-Bone Transplants Utilizing Radioactive Cobalt. Preliminary Report. Paul H. DeVries, Carl E. Badgley, and J. Ted Hartman. *J. Bone & Joint Surg.* **40-A**: 187-202, January 1958. (P. H. D., 116 N. Tucson Blvd., Tucson, Ariz.)

Because frozen, boiled, or autoclaved bone transplants resulted in too high an incidence of wound infections and were otherwise unsatisfactory, sterilization by radiation was investigated. Radioactive cobalt proved to be effective for this purpose. When combined with a freeze-drying process, radiation sterilization utilizing radiocobalt was found to be an effective method of maintaining a bone-bank.

Irradiated bone transplants functioned satisfactorily both experimentally and clinically. In 104 surgical procedures in which irradiated homogenous bone transplants were used, 5 postoperative wound infections occurred, but these were not felt to be due to the transplanted bone. The encouraging overall clinical results in these procedures prompt continued use of irradiated homogenous bone transplants.

In the discussion of this paper it was pointed out that the bone transplants were treated with a specifically designed machine containing 10,000 curies of cobalt. A calculation was made to indicate the time required for delivering four million roentgen equivalent physicals, which the authors say is necessary to inactivate the most resistant viruses. With a therapy unit of 1,000 or 1,500 curies, the time would be well over 400 hours.

Seventeen roentgenograms; 7 photomicrographs; 6 photographs; 2 tables.

RICHARD A. ELMER, M.D.

Atlanta, Ga.

In Vivo Localization of Colloidal Au¹⁹⁸ Intravenously Injected in Polycythemia Vera; Preliminary Report. Lars Engstedt, Sixten Franzén, Lars Jonsson, and Lars-Gunnar Larsson. *Acta radiol.* **49**: 66-71, January 1958. (Radiumhemmet, Karolinska Sjukhuset, Stockholm, Sweden)

The study reported here was undertaken to determine the distribution in the body of intravenously administered colloids. It had been theorized that this was dependent upon the reticuloendothelial system.

Two millicuries of gold were injected into 19 patients with polycythemia vera and 4 patients with locally advanced oral carcinoma without bone or liver involvement and in good general condition.

In the controls (the 4 patients with oral carcinoma) the highest counts were obtained over the liver. The counts were also increased over the spleen, pelvis, spine, skull, and thorax, but to a lesser degree. In the patients with polycythemia vera, the liver counts were also the highest. The splenic counts were higher in this group than in the controls, but were lower than in the liver.

The counts over the long bones were centrally located in the controls but in the patients with polycythemia vera were especially marked in the epiphyseal regions. The overall long bone counts were much

greater in the group being studied than in the controls. This probably indicates the presence of active reticuloendothelial cells and active hematopoiesis. Such a procedure could be used as a method of localizing active bone marrow.

Six scintigrams.

C. A. REID, M.D.

St. Vincent's Hospital, New York

Further Observations on the Lymphatic Pick-Up of Radioactive Silver-Coated Gold Colloid Administered Intrathoracically to Dogs. R. A. Matuska, P. F. Hahn, R. I. Carlson, S. H. Auerbach, and G. R. Menely. *J. Thoracic Surg.* **35**: 135-138, January 1958. (R. A. M., 4247 Hamilton St., Cincinnati, Ohio)

Mongrel dogs were operated upon under aseptic conditions, under intravenous barbiturate anesthesia. At operation or during the postoperative period, radioactive silver-coated gold colloid was injected into the pleural space or mediastinum. The dogs were sacrificed at intervals ranging from two to forty-four days after injection of the colloid material.

Varying results were obtained. There was total necrosis of the nodes and the immediate surrounding tissues in those instances in which the radiologic effect was the greatest. In the less severe cases, the nodal architecture was partially preserved, but with a complete loss of lymphocytes; plasma cells and reticulum cells were prominent survivors in these nodes. Erythrophagocytosis was noted in lymph nodes with high counts in animals that were sacrificed early. It is notable that the vascular damage frequently assumed a form which strikingly resembled fibrinoid necrosis.

It can be concluded from the experiments that the lymphatics of the parietal and mediastinal pleura in dogs drain into the mediastinal lymph nodes bilaterally. These nodes may be destroyed by the intrapleural or intramediastinal injection of radioactive silver-coated gold colloid. If these findings can be shown in the human being, a prophylactic type of mediastinal dissection may be added to pneumonectomy in the treatment of patients with resectable bronchogenic carcinoma. No harmful effects have been noted following intrapleural injections of the colloid, but there was a 25 per cent incidence of bronchial stump dehiscence in pneumonectomized dogs following intramediastinal administration.

The authors are currently treating human beings with the gold colloid following resective surgery for bronchogenic carcinoma.

Three tables.

FRANK T. MORAN, M.D.

Auburn, N. Y.

Kinetics of Strontium Metabolism in Man. Göran C. H. Bauer and Robert D. Ray. *J. Bone & Joint Surg.* **40-A**: 171-186, January 1958. (R. D. R., University of Illinois College of Medicine, Chicago, Ill.)

Strontium metabolism was investigated in 5 adult males by external counts over various body locations, and studies of serial samples of serum, urine, and stools for seven to fourteen days following parenteral administration of the radioactive isotope, S⁸⁶.

With the use of the d-c analogue computer, it was possible to simulate the blood disappearance and excretory-appearance curves with a four-compartment model and two bleed-outs, one representing loss of isotope from the exchangeable strontium space due

to new bone formation (accretion) and one representing excretion.

The rates involved in this model suggested that the four compartments represent serum, extravascular-extracellular fluid, intracellular fluid, and bone strontium. The last represents about half of the total exchangeable strontium space.

The model is presented as a possible point of departure for further investigations of the many unknowns which remain to be defined for a true representation of the kinetics of strontium, calcium, or other bone mineral metabolisms.

Nine figures.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

RADIATION EFFECTS

Radiation Dose to Gonads from Diagnostic X-Ray Exposure. Thomas A. Lincoln and Edwin D. Gupton. *J.A.M.A.* 166: 233-239, Jan. 18, 1958. (T. A. L., Post Office Box P, Oak Ridge, Tenn.)

The authors report estimations of the dose to gonads and to the skin at the focal point of entry during roentgenographic procedures routinely performed on employees of the Oak Ridge National Laboratory (ORNL), and make suggestions for the reduction of future exposures from such procedures. The basic data of the study were obtained from direct measurements of radiation in a tissue-equivalent phantom and in air at table tops during typical diagnostic exposures, and from the employees' clinical records.

The gonad dose for certain exposures depended on four factors—the size of cone used, filtration, kilovoltage, and milliamperage seconds. The average total gonadal dose per year was 0.013 rads for males and 0.035 rads for females. This gives an average gonad dose of less than 1.5 rads in thirty years, which is below the 4 rads allowed to age thirty by the International Committee on Radiation Protection. This study however, did not account for examinations done in childhood and apart from work.

Three simple steps are emphasized for improvement of the situation: use of a cone or diaphragm of minimum practicable size to reduce the dose to all areas outside the field of interest; filtration at the source to reduce the amount of soft, scattered radiation, and employment of the highest kilovoltage and lowest milliamperage technique which is practicable. The use of fast screens and films and image amplification is also recommended.

Five figures; 9 tables.

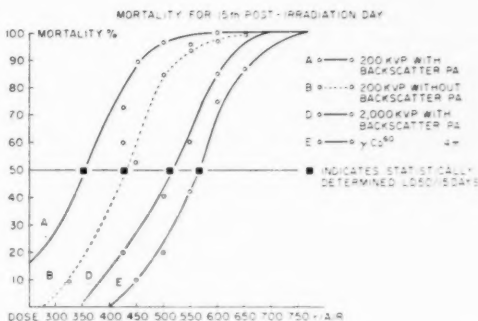
J. S. ARAJ, M.D.
Toledo, Ohio

Lethal Effect of 200, 2000 Kvp X- and ^{60}Co Gamma Rays in Guinea Pigs. F. Ellinger, E. B. Cook, and J. E. Morgan. *Atompraxis* 4: 17-23, January 1958. (Naval Medical Research Institute, National Naval Medical Center, Bethesda, Md.)

Two previous publications (*Radiology* 44: 125, 1945, and 66: 878, 1956) form the background for this report. It is an excellent example of careful planning and attention to details to bring out the subtle differences in effects produced by various types of ionizing radiations under different exposure conditions.

Curves are reproduced (see accompanying figure) which clearly bring out the effective back-scatter and the significant lower lethal effects of 2,000-kvp radiation contrasted to 200-kvp and the still further difference exhibited by cobalt-60 gamma rays with 4 π geometry.

The difference between the mortality following postero-anterior and lateral exposure to 200 kvp, without back-scatter, is considered as probably due to different biological mechanisms, as inferred from



Influence of variation of type of ionizing radiation on mortality.

the distinctly different slope of the mortality curve obtained after unilateral exposure.

In view of the fact that in one animal species the same type of radiation if administered with variation in the exposure conditions produces significantly different mortality rates and also that a change in the type of ionizing radiation may cause very significant differences in mortality, it is suggested that utmost reserve be used in the extrapolation to man of quantitative data concerning radiation mortality in animals.

Nine figures including 2 roentgenograms; 3 tables.

SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Chronic Gamma Irradiation. Effects on the Peripheral Blood and Hemopoietic System of Female Guinea-Pigs. P. W. Edmondson. *Brit. M. J.* 1: 363-368, Feb. 15, 1958.

It has been established that chronic gamma and x-irradiation produce anemia and pancytopenia in all species, the onset of anemia being a late and relatively sudden event. The author sought to discover, by means of serial marrow studies, whether the abrupt onset of anemia was presaged by marrow changes and to what extent these were reflected in the peripheral blood.

The experimental animals, guinea-pigs, were divided into four groups, two control groups, a third, irradiated, group for blood study only, and a fourth group for blood and serial marrow studies. Irradiation was by cobalt-60, 10 r being given per sixteen-hour day until death. The first death occurred at 114 days and the last at 345 days, while the mean survival time was 178 days. Complete blood examination and marrow studies were done every nine or ten days throughout the experiment, and postmortem studies were done in all irradiated animals and on 4 controls.

The findings in the peripheral blood confirmed observations by other investigators that severe anemia of sudden onset is terminal. The depression of the leukocytes is partly due to the decrease in the number of lymphocytes, but much more to a severe reduction in the heterophil numbers.

The platelet count showed a drop at the beginning of irradiation but returned to almost normal values at forty to fifty days (450-500 r), thereafter falling sharply without secondary rises.

Marrow studies revealed that with 100 to 1,000 r (ten to a hundred days), the myeloid cells dropped, while the proportion of normoblasts and lymphocyte type cells rose. The megakaryocytes increased after 400 r but dropped at 600 r and continued to decrease to complete absence. Though these findings show change in the differential picture of marrow smears, the author concludes that smears do not give a reliable indication of the degree of irradiation injury or the imminence of terminal stage. No failure of erythropoiesis was observed.

Four photomicrographs; 5 charts; 1 table.

J. S. ARAJ, M.D.
Toledo, Ohio

Long-Term Study of X-Irradiated Rabbits with Bone-Marrow Homotransplants. K. A. Porter and J. E. Murray. *J. Nat. Cancer Inst.* 20: 189-205, January 1958. (J. E. M., Peter Bent Brigham Hospital, Boston, Mass.)

Male New Zealand white rabbits were exposed to 1,100 r whole-body x-irradiation fractionated into two doses, 600 r initially and an additional 500 r twenty-four hours later. Subsequently, they were injected intravenously with homologous bone marrow from a female donor and treated with tetracycline hydrochloride for three weeks.

In 65 per cent of the animals, persistence and function of the marrow homotransplant occurred as shown by the appearance of female heterophils in the peripheral circulation. Of this group, 15.5 per cent died early from gastric perforation; in 19 per cent, the marrow transplant was ultimately rejected by the host; 27 per cent died from infection at thirty-three to forty days with the marrow transplant intact and still functioning; 38.2 per cent were alive and well with an intact marrow homotransplant at thirty-two weeks.

In 30 per cent of the animals the marrow transplant was unsuccessful. Of this group, 16.8 per cent died from gastric perforation and 41.6 per cent died from infection at thirteen to twenty-five days; in 41.6 per cent the animal's own bone marrow regenerated.

Treatment with tetracycline hydrochloride reduced the cumulative mortality of the irradiated rabbits from 90 to 75 per cent at thirty-two weeks. The addition of bone marrow produced a further reduction to 60 per cent.

Fractionation of the exposure reduced the occurrence of immediate postirradiation death in shock.

Seven photomicrographs; 4 charts; 3 tables.



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